vol. 5, no. 1 Spring/Summer 1996

InterRidge News

InterRidge Update

Membership

Since our last update, the InterRidge community has continued to grow. At the beginning of 1996, Germany upgraded its membership from Associate to Principal. The German ridge crest research community has energetically undertaken development and co-ordination of the DeRidge Program, recently publishing the first formal issue of the *DeRidge Newsletter*. InterRidge is also very pleased to welcome Norway as a new Associate Member. Norway announced its intention to become an Associate Member for 1996, 1997 and 1998 at the start of this year. The number of Corresponding Members has also grown with the welcome addition of Denmark. For 1996, InterRidge now counts 6 Principal Members (France, Germany, Japan, Spain, the United Kingdom, the United States), 2 Associate Members (Norway, Portugal) and 11 Corresponding Members (Australia, Canada, Denmark, Iceland, India, Italy, Korea, Mexico, Russia, Sweden, Switzerland).

InterRidge Office Transfer

The University of Durham's 3 year term as host to the InterRidge Office will end in December 1996. In anticipation of the scheduled transfer of the InterRidge Office to another member nation, a call for bids was announced in January 1996 over the e-maillist. Individuals, groups or institutions from any 1997 Principal Member Nation were invited to submit bids to become hosts. Further details are available from the InterRidge Office.

Upcoming Events

Planning is underway for two large symposia/workshops in conjunction with three international programs.

The Ocean Lithosphere & Scientific Drilling into the 21st Century Workshop will be convened by Drs. H. Dick and C. Mével at Woods Hole, MA, USA on 26th - 28th May. This joint effort of the JOIDES Ocean Drilling Program, the International Association of Volcanology and Chemistry of the Earth's Interior and InterRidge aims to plan an integrated program of scientific ocean drilling to evaluate and extend current models for the formation of a laterally complex and heterogeneous ocean lithosphere.

Reykjavik will be the site of a joint ***FARA-InterRidge Mid-Atlantic Ridge Symposium*** to be held at The Nordic Volcanological Institute of the University of Iceland on 19th - 22th June. The Symposium will be convened by Drs. C.H. Langmuir and H.D. Needham and is being planned in collaboration with Drs. K. Gronvold, R.C. Searle and H. Sloan. The Symposium marks the end of the five year FARA Project of Franco-American co-operative study of the Mid-Atlantic Ridge. A carefully planned program of invited and contributed presentations will synthesis the extensive body of work carried out

Dr. Heather Sloan, Editor.
Dr. Ruth Williams, Assistant Eidtor
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under the auspices of FARA. In addition to two half-day field trips included in the Symposium program, a three-day pre-Symposium field trip is planned, giving participants the rare opportunity to make real-time, direct observations of the ridge.

WWW

The InterRidge World Wide Web home page continues to evolve with the addition of a series of pages announcing Piggy-back Proposals and offers of ship time. There are also newly updated schedules of ridge crest cruises - many thanks to all of the Principal Investigators who sent information on their upcoming cruises. As the Phase 2 Project activities get underway, new pages will appear reporting their progress.

Heather Sloan
InterRidge Co-Ordinator

Calendar

Geological Society of America Penrose Conference
Tectonic Evolution of the Gulf of California and its Margins
Loret, Baja California Sur, Mexico, 16-21 April 1996

European Geophysical Society Session: Mid-Ocean Ridge Processes
The Hague, The Netherlands, 6-10 May 1996

JOIDES-ODP/InterRidge/IAVCEI Conference:
Ocean Lithosphere & Scientific Drilling into the 21st Century
Woods Hole, MA, USA, 26-28 May 1996

InterRidge/FARA Mid-Atlantic Ridge Symposium
Iceland, 19-22 June 1996

ECTM-NorFA Sponsored Summer School on
Ocean Crust and Ophiolites
Iceland, 23-31 August 1996

XXV General Assembly of the European Seismological Commission:
Mid-Ocean Ridge Processes Session
Reykjavik, Iceland, 9-14 September 1996

InterRidge Steering Committee Meeting
17 &18 September 1996
(Provisional)

Geology and Geophysics of the Indian Ocean
Goa, India, 21-24 October 1996

SCOR General Meeting
Southampton, UK, 16-19 September 1996

International Symposium: Plumes, Plates and Mineralization (PPM'97)
Pretoria, South Africa, 14-18 April 1997

International Symposium on Hydrothermal Vent Biology
Madeira, Portugal, 20-24 October 1997

InterRidge Phase 2 Projects

Back-Arc Basin Project

RV Maurice Ewing cruise 9512
Geophysical Investigation of Melt Bodies beneath the Valu Fa Ridge, Lau Basin (SW Pacific)

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Introduction

The Valu Fa Ridge (VFR), which has an intermediate spreading rate of ~60 mm/yr, is an active back-arc spreading centre in the Lau Basin, SW Pacific (Figure 1). This ridge, and the Lau Basin in general, have been the target of a number of multi-disciplinary studies over the last decade. During three cruises by *RV Sonne* between 1985 and 1987, a large number of rock and mineralisation samples were collected, and the ridge was surveyed by underwater cameras and swath bathymetry (Jenner et al., 1987; von Stackelberg et al., 1988; Frenzel et al., 1990; Davis et al., 1990). Based on this work, a morphological segmentation of the ridge was recognised which sub-divides it, in the area surveyed, into three distinct segments which von Stackelberg et al. named the Southern, Central and Northern Valu Fa Ridges (SVFR, CVFR and NVFR). Diving by Nautile on the northern part of the CVFR in 1989 discovered one of the most active hydrothermal fields known (the 'Vai Lili' field at 22° 13' S), with black smokers emitting fluids with temperatures up to 400°C (The Nautilau Group, 1990; Fouquet et al., 1991). GLORIA data were collected over much of the central part of the basin in 1988 (Parson et al., 1990), leading to the first clear definition of the pattern of seafloor spreading here and of its relation to the Valu Fa spreading centre. In the winter of 1990, ODP drilling (leg 135) occurred – the main objective of which was to determine the evolution of the basin. Owing to the extent of existing UK involvement in these Lau Basin studies, this region was selected by the BRIDGE programme as one of its four areas of interest on the global ridge system as a whole. Our programme of research was funded by BRIDGE, and this funding included ship time aboard the *RV Maurice Ewing* during November and December 1995.

In 1988, a dense grid of seismic lines was collected over a 35 km long morphological segment of the ridge system, primarily along the CVFR and across a small overlapping spreading centre (OSC) at its northern end (*RRS Charles Darwin* cruise CD34/88; Sinha, 1988). That experiment showed that the whole of the ridge system is underlain by a robust magma chamber (Collier and Sinha, 1990; 1992a,b). Interpretation of the 1988 data also revealed a number of features of the along-axis variations in magma chamber geometry and melt processes, and their relation to sea floor morphology. Our reason for returning to the Lau Basin was to investigate these features further using a variety of geophysical techniques, chiefly to: (a) investigate the physical properties of the crust beneath the ridge axis by controlled source electromagnetic (CSEM) and wide-angle seismic methods; (b) investigate the distribution of seismic velocities, and by implication melt fraction, beneath a magmatically robust OSC and (c) allow a comparison of magmatic structure and crustal thickness between the OSC and elsewhere on the CVFR.

Our reason for choosing a combined CSEM and wide-angle seismic approach is our conviction that the combination of electrical resistivity and seismic velocity determinations will provide much

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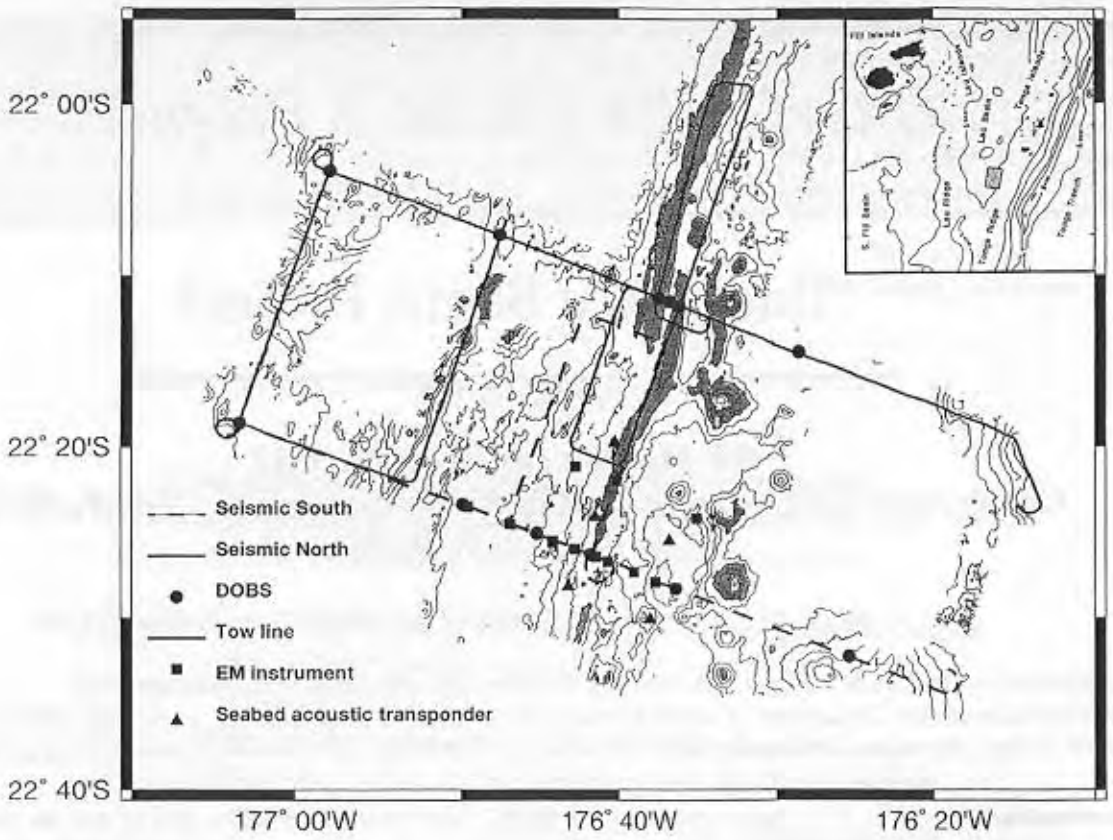

Figure 1. Summary track chart of cruise Ewing 9512. The insert shows the location of the Lau Basin. The gridded swath bathymetry data collected during this cruise have been used as a background, with the shaded area showing the location of the Central and Northern Valu Fa Ridges and the OSC. The locations of all seabed instruments involved in the main seismic and electromagnetic experiments are shown, together with shooting and tow lines.

tighter constraints on magmatic structure and properties than any single geophysical parameter. The present study builds on the success of a similar experiment conducted jointly by the Durham, Cambridge and Scripps groups on the Reykjanes Ridge (another BRIDGE area) at 57°N (Sinha et al., 1994; 1996). That experiment proved for the first time the viability of combining controlled source seismic and electromagnetic techniques within a single cruise, and that these techniques can complement each other in locating and mapping the extent of axial magma bodies. The axial volcanic ridge studied during the Reykjanes experiment has been shown to be underlain by a significant crustal low velocity and high conductivity zone – the first time a crustal melt body has been unequivocally imaged using either seismic or CSEM techniques beneath a slow spreading ridge (Sinha et al., 1996). Applying this integrated geophysical approach to exploration of the VFR, where a magma chamber is already known to exist, will enable us to investigate the accretionary processes in greater detail than has been possible previously using only normal incidence and very limited wide-angle seismic constraints.

The experiment

The first objective of this cruise was to obtain CSEM data from the southern part of the CVFR (Figure 1). This dataset complements the existing seismic reflection images of this area, and provides improved constraints on the nature, dimensions and physical properties of a region of low melt fraction believed to be present within the crust, flanking and underlying the axial magma chamber reflector (which has been shown to correspond to a much smaller, sill-like volume of very high melt fraction). It would also provide constraints on the distribution of porosity in the upper crust – the source zone for hydrothermal circulation systems, and the site of thermal and chemical exchanges between sea water and lithosphere. The CSEM experiment consisted of a line of LEMUR and ELF horizontal electric field receivers deployed across the axis of the southern CVFR, where the brightest and widest (apart from the OSC) axial magma chamber reflector was imaged in the 1988 dataset. Two additional LEM long-wire receivers, capable of measuring source signals at ranges of up to 50 km, were deployed at the western end of the profile. The Cambridge deep-towed electromagnetic transmitter (DASI) was then used to make eight transmitting runs along five profiles. Three of these lines were ridge parallel: one running along the axis, another located 5 km off-axis to the west and a third in an off-axis basin 8 km to the east. The remaining two lines ran across-axis (Figure 1). We operated DASI at frequencies of between 0.25 and 8 Hz, aiming to obtain maximum spatial coverage at a small number of carefully chosen frequencies, and arranged transmitter positions and orientations so as to generate both ridge-parallel and ridge-normal polarisation patterns (Unsworth et al.,

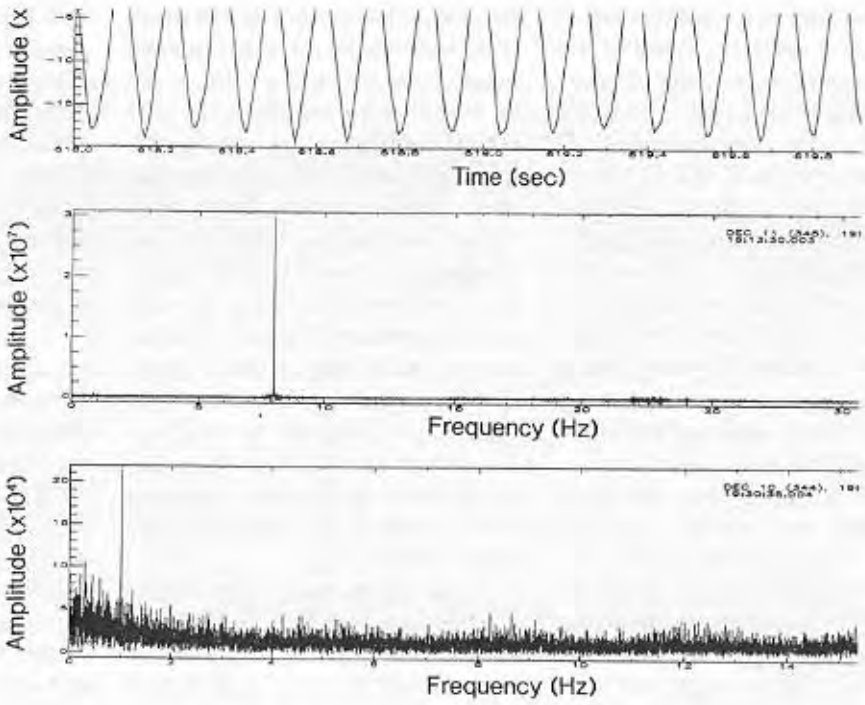

Figure 2. Examples of controlled source electromagnetic data, recorded by a Cambridge seafloor electric field instrument located on the axis of the Valu Fa Ridge, at the intersection of the across-axis and along-axis transmitter tow lines. a) Example time-series data, showing 8 Hz transmissions from DASI. Source-receiver range is ~ 2 km. b) Amplitude spectrum of the data shown in (a). The spectrum is dominated by the 8 Hz transmission frequency, but the third harmonic of the transmitted square wave signal can also be seen clearly at 24 Hz. c) Amplitude spectrum of data recorded by the same instrument at longer (~5 km) range. The spectrum is again dominated by the DASI transmission frequency, which in this case is 1 Hz.

1993). We navigated the CSEM experiment using the UK Research Vessel Services' (RVS) OCEANO long-baseline acoustic navigation system, which was tied to absolute co-ordinates by GPS. In total, 156 km (68.5 hours) of transmissions were recorded by an array of nine working receivers, unfortunately with the loss of one instrument. An example of the recorded data is shown in Figure 2.

Although the 1988 cruise provided excellent seismic reflection images and seismic velocity profiles (using sonobuoys) through the upper crust down to the axial magma chamber reflector on-axis and down to about 4 km depth off-axis, prior to this cruise we could only infer seismic velocities within the low velocity zone from the amplitudes of reflections. In addition, we had no information on the depth to the Moho in this area. The digital ocean bottom seismometer (DOBS) data from the seismic component of our experiment will provide an across-axis image of the seismic velocity structure down into the upper mantle, and enable us to measure crustal thickness and the geometry and thickness of the melt body(s) along and across-axis. The seismic experiment was divided into two sections – Seismic South and Seismic North – named in relation to their location within the work area.

For the Seismic South experiment (Figure 1), six DOBSs were deployed at intervals along an ~80 km across-axis line. The line was centred on the CVFR where the brightest melt reflector was observed in the CD34/88 reflection data, and was coincident with the main across-axis CSEM profile. Using the *RV Ewing's* large volume (~8500 in³) airgun array fired at 100m intervals, a grid of lines in addition to the ~80 km across-axis line was shot. This grid included two lines shot ridge parallel, off-axis to the west, an along-CVFR line and a shorter across-axis line located towards the northern end of the segment. Along each of these lines sonobuoys were deployed not only to provide detailed upper crustal velocity information, but also to reverse the ridge parallel lines which only had one DOBS located at the southern end.

Each of the DOBSs was fitted with a 3-component geophone package, in addition to a hydrophone, in order to maximise the chances of making high quality recordings of S-waves. Airgun shots provide closely spaced traces which maximise trace-to-trace coherence of phases. This allows the recognition of late arriving and low amplitude P-waves and detailed travel time and amplitude modelling of the P-wave velocity structure. It was also an objective of this experiment to study S-wave structure. The S-wave velocity structure and, equally importantly, any evidence of S-wave shadowing due to high attenuation will provide important constraints on the physical state of crustal rocks. The unsedimented seabed near the ridge axis is the source of significant conversion of P- to S-wave energy at the water-rock interface, and these signals are readily observable in the wide-angle seismic datasets. The DOBSs were programmed to record in a windowed mode, mainly to enable collection of four channel data at 200

sps – resulting in a trace spacing of ~200m at a surveying speed of 4.9 knots. Each DOBS recorded the shots fired along all six of the lines in the southern survey, hence providing 3D ray coverage of the CVFR (Figure 1).

The Seismic North experiment was conducted in a similar manner to Seismic South except that the ~80 km seismic line was centred on the OSC which offsets the Central and Northern Valu Fa Ridges (Figure 1), where the greatest melt accumulation is thought to exist. This time the grid of additional lines consisted of three located off-axis to the west, one along the NVFR, and another along the CVFR. This last profile extended some 25 km north past the end of the segment, to investigate the structure of the spreading tip. A shorter across-CVFR axis profile was also shot slightly to the south of the 80 km line, and this will help to map the extent of the OSC melt body and its relation to the melt beneath the CVFR axis. Sonobuoys were deployed along some lines to increase the near surface resolution and provide line reversal. At the WNW end of both experiments, ridge-parallel lines provide a reversed profile which will allow us to determine the structure of older crust which is possibly of island-arc rather than seafloor spreading origin, and which is believed to predate the onset of spreading brought about by the passage of the southward propagating Valu Fa rift tip through this area within the last 1 Ma. At their ESE ends, both experiments extend out on to the edge of the Tonga Platform.

In total, 62640 seismograms were recorded along eleven 2D lines, equivalent to ~1 Gbyte of DOBS data. Each instrument was recovered without loss. Data quality is extremely high, with low levels of background noise. Some interesting features can be noted on inspection of the first record sections to be constructed. These include P-wave shadow zones, as would be expected in the presence of intra-crustal melt bodies, and microearthquakes (Figure 3). The 2-D data will be analysed using 2-D seismic interpretation methods, based on forward modelling of travel times, amplitudes and wave forms. Since each DOBS effectively recorded a 3-D, areal dataset it will also be possible to analyse delay times associated with ray paths running obliquely to the trend of the ridge.

Single channel seismic reflection data were digitally recorded along all of the lines while wide-angle shooting. The reflection data will be used to provide information on the near-surface structure, and to locate and determine the thickness of any off-axis sediment ponds. This will be particularly important at distances greater than 15 to 20 km off-axis, which is outside the coverage of the 1988 reflection dataset. An example of the raw data is shown in Figure 4. Even on these rather crude unprocessed sections, a reflection event corresponding to a sub-axis magma chamber can clearly be seen.

Throughout the cruise we were also able to collect a significant amount of swath bathymetry data. High quality bathymetry data will play an important role in the interpretation of both the seismic and the electromagnetic data (EM) – since both seismic and EM responses are substantially affected by seafloor topography. The preliminary gridded data are shown as a background to Figure 1 and represent an area of approximately 3225 km². Both CVFR and NVFR segments and the OSC can clearly be seen. Gravity data were also collected throughout the cruise together with total field magnetic data. In addition, we collected bathymetry, gravity and magnetic data for most of the transit from Suva (Fiji - the pre-cruise port call) to the work area.

Finally, in the work area we collected a sound velocity profile of the water column at 22° 25.90'S 176° 35.92'W using a sound velocity meter. This profile was supplemented by 12 XBT deployments, the most intriguing of which appeared to show the presence of a major temperature anomaly within the bottom 200m of the water column (Figure 5). The site of this XBT is close to the southern end of the CVFR axis. Three further XBTs at distances of 500m from this site showed no anomaly. The magnitude of the anomaly seems far too great for even the largest known hydrothermal plumes. Researchers who wish to make use of the water column data should contact either of the first two authors.

Data interpretation

The preliminary stages of data processing and interpretation are still underway. Once complete, we plan to generate models of the crust for each of the 2-D seismic lines running both along and across-axis. The seismic structures will then be combined with resistivity models derived from the CSEM data by 2-D modelling. The seismic determinations of crustal thickness and its variation along and across-axis will be related to gravity observations. Sinha (1995) has shown that variations of about 20 mgal in the mantle Bouguer gravity anomaly ex-

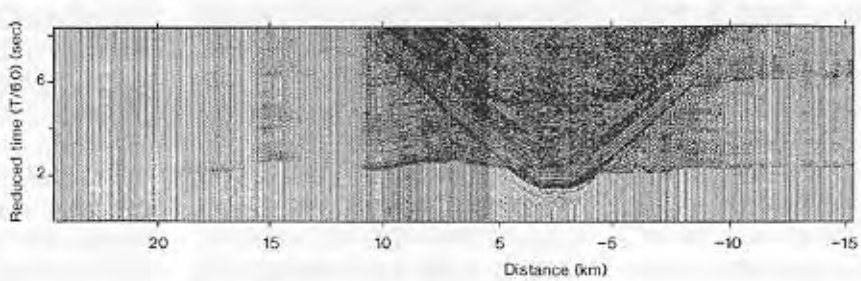

Figure 3. Example wide-angle DOBS seismic record section showing crust and upper mantle diving rays and P-wave shadow zones associated with axis locations. The darker area on the record section is caused by overlapping regions of different grid lines from which the section is constructed, and merely represents a greater density of traces per km (cf. Figure 1).

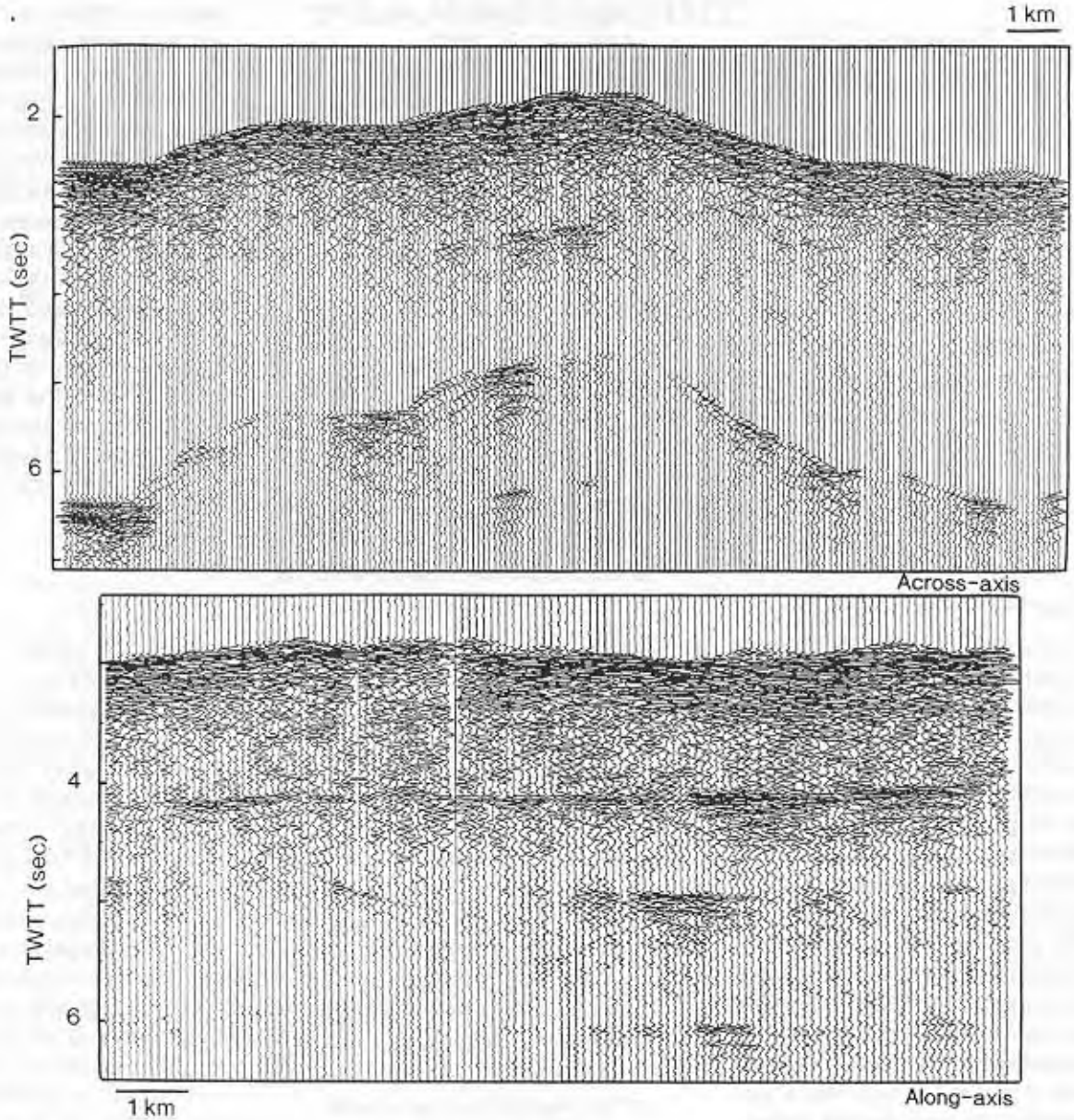

Figure 4. Example seismic reflection data collected along and across-axis at the southern end of the CVFR.

ist between the southern end of the CVFR and the OSC. Recent studies of gravity anomalies on the Mid-Atlantic Ridge have indicated that there, such mantle Bouguer anomaly variations are due primarily to crustal thickness variations. The seismic and gravity data collected during this cruise, together with the gravity data from 1988, will allow this to be tested in an intermediate spreading, back-arc setting.

Specific aspects of the ridge structure that we plan to investigate using all of the collected data are:

(i) how does the porosity of the upper crust vary across the VFR?

(ii) how does the electrical resistivity of the middle and lower crust vary across the VFR, and how does this correlate with the seismic velocity structure and with intra-crustal seismic reflectors seen in the 1988 dataset?

(iii) given both the seismic and electromagnetic data, what can we infer about the across-ridge temperature structure and the nature of the molten and partially molten regions?

(iv) how does seismic crustal structure vary across the OSC?

(v) what can this tell us about the nature of magma injection, migration and accumulation in the crust beneath this spreading centre offset? and

(vi) what can we learn from all of the above about the process of construction and evolution of oceanic crust at the CVFR? In particular we shall use the OSC data to test the interpretation of Collier and Sinha (1992a,b) that the OSC segment of the spreading centre is particularly magmatically vigorous – a proposition which has profound implications for the nature of the relationship between the along-axis variations in magma supply from the mantle, and the morphological expression of ridge segmentation.

Acknowledgements

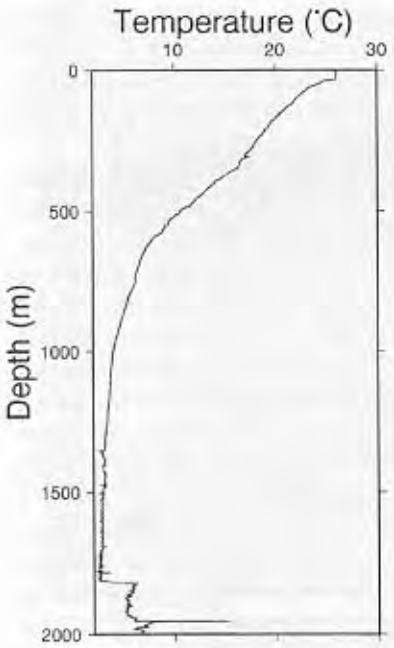

Figure 5. Example XBT data showing the possible location of a hydrothermal plume

We wish to thank the master, officers and crew of the *RV Maurice Ewing* and the support staff of Lamont-Doherty Earth Observatory for their efforts in ensuring a successful and enjoyable cruise. Ship time was funded by the BRIDGE Programme of the UK's Natural Environment Research Council which also supported the work through research grants (GST/02/1123 and GR3/9414) and research studentship (GT4/95/72/E) awards to Cambridge and Durham Universities. We would also like to thank the Royal Navy's Hydrographic Office for supplying the XBT probes free of charge.

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4-D Architecture of the Oceanic Lithosphere

Submersible Investigation of Highly Contrasted Magmatic Activities Recorded on Two Segments of the Mid-Atlantic Ridge near 34°52'N and 33°55'N

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During the OCEANAUT cruise of the French vessel *RV Nadir* and the submersible Nautile (August-September 1995), two second order segments of the Mid-Atlantic Ridge (MAR), located between the Oceanographer (35°15'N, 36°10'W) and the Hayes (33°30'N, 38°W) transform faults, were explored (Figures 1 and 2). This region of the MAR was recently mapped by a multibeam bathymetric system (SIMRAD EM12) during the 1991 FARA-SIGMA cruise of the *RV l'Atalante* south of the Azores platform (Needham et al., 1991; Detrick et al., 1995). The Nautile undertook 20 dives along and across two of the longest segments located near 34°52'N and 33°55'N (Figures 3 and 4), and showing a noticeable morphostructural contrast over a distance of less than 100 km.

The central topographic high of the northern segment (working area A) corresponds to the top of a median ridge (1650-2000 m depth). Perpendicularly to the MAR axis, the central high is intersected by a broad (8 km wide) band of conical volcanoes (1000-1700 m depth) which extends on both sides of the ridge segment (for at least 20 km on the eastern side). The size of the individual volcanoes is 2-3 km in diameter and 200-500 m in height above the average depth of the surrounding seafloor. At 10 mm/yr half-spreading rate deduced from magnetic anomalies, the surveyed volcanoes are built on crust which is up to 2 Ma old. The central high of the southern segment (working area B) is deeper (3050 m) and is devoid of median ridge. The topography suggests a more tectonic stage with low volcanic activity.

Previous large scale geochemical studies of dredged volcanics from the MAR axis have shown the influence of the Azores hot spot through a progressive enrichment of the Mid-Ocean Ridge basalts (MORBs) north of the Hayes Fracture Zone (Schilling, 1975; Le Douaran and Francheteau, 1981; Schilling et al., 1982). The collection of dredged samples from the MAR axis between the Hayes and Oceanographer transforms (White and Schilling, 1978; Schilling et al., 1982) was recently complemented by closely-spaced (5 to 10 km) mini-core sampling along the MAR axis between 32°N and

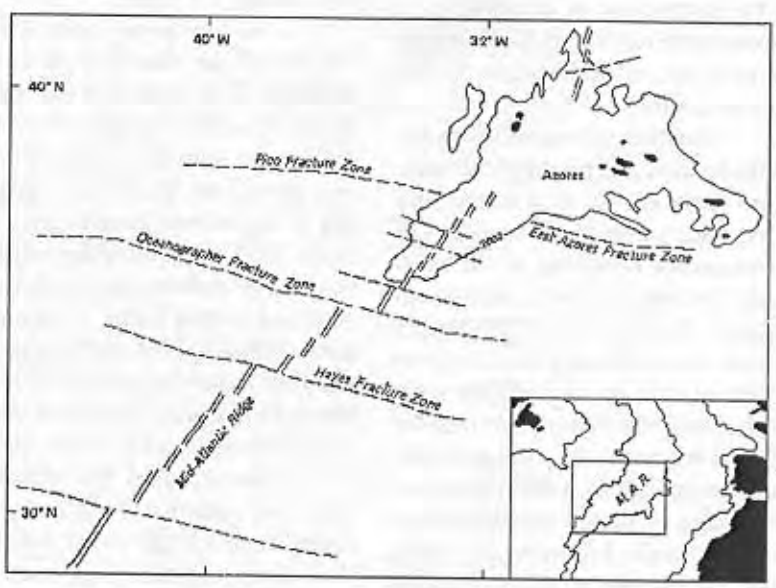

Figure 1. General location of the working area during the OCEANAUT diving cruise (*RV Nadir*, submersible Nautile) in the North Atlantic Ocean.

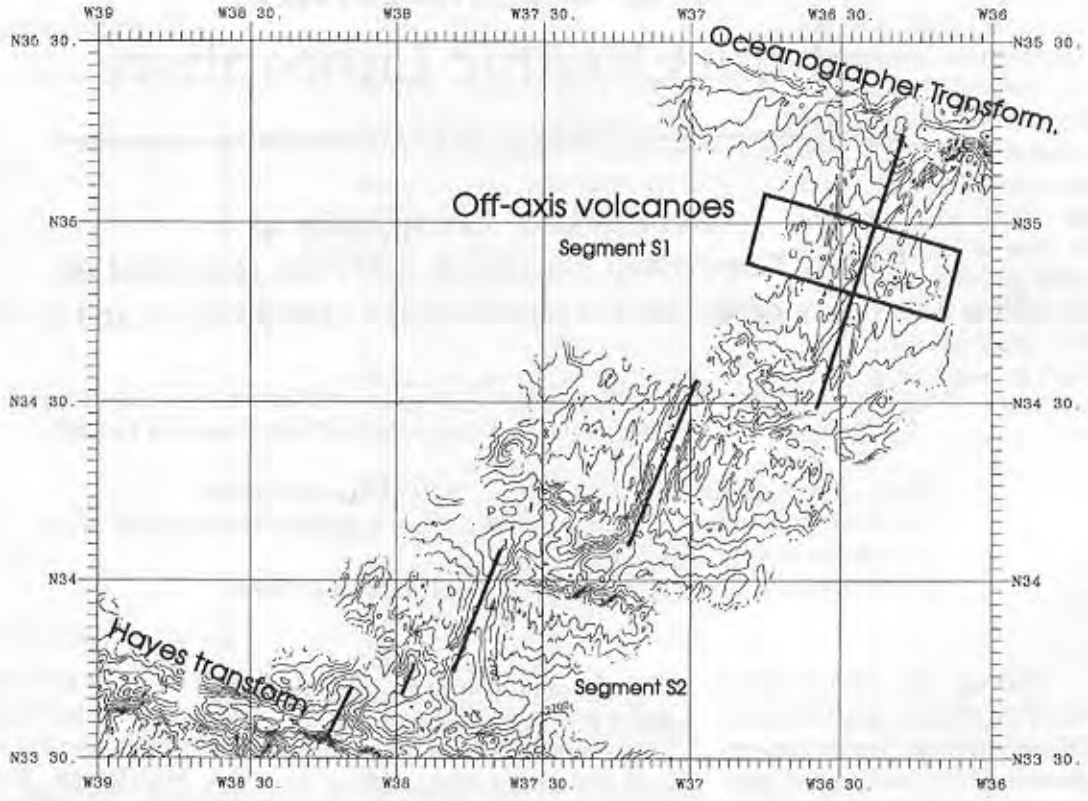

Figure 2. Bathymetric map of the Mid-Atlantic Ridge between the Oceanographer and the Hayes transforms (contour interval 300 m). Data from the FARA-SIGMA cruise of the *RV l'Atalante* (Needham et al., 1991). The working areas during the OCEANAUT cruises are second-order ridge segments S1 and S2. The box represents the band of off-axis volcanoes which intersects the northern segment S1 at the level of its central high.

41°N during the 1992 FAZAR cruise of the *RV Atlantis II* (Langmuir et al., 1992). Gabbros were also sampled in this area (dredges of the *RV Boris Petrov*, J.F. Casey, pers. comm.) close to the intersection of the ridge and a second order ridge-axis discontinuity located slightly north-east of the Hayes transform.

Detailed submersible studies of the tectonic and petrological variations related to magmatic and amagmatic accretion are necessary to constrain the dynamics of the magmatic processes along mid-ocean ridges. During the OCEANAUT cruise, about 250 rock samples were collected from the axis and the walls of the inner rift valley and from the off-axis volcanoes. In addition to submersible operations, a detailed surface ship magnetic survey was carried out during the night. From a total of about 2400 km of parallel, closely spaced (1 mile) magnetic profiles (30 to 23 miles long, 10 Kt ship velocity) completed by 600 km of transverse profiles, two thirds were corrected for diurnal variation using a reference magnetometer placed at about 1500 m above the seafloor.

Preliminary Results of the OCEANAUT Cruise.

The Northern Segment S1 : The top of the central high of the northern MAR segment S1 is represented by a 300 m high median ridge dividing the inner floor of the rift valley into two troughs: 1) the topography of the eastern trough varies between 2000 and 2300 m depth and 2) that of the western trough between 2000 and 2100 m depth. A total of 8 dives (OT-01 to 03 and OT-15 to 20) were devoted to the study of the inner valley, including the median ridge and the three first steps of the walls on both sides of the rift valley. Recent lobate, ropy and huckly lava flows were found on the eastern trough which is likely to represent the most recent active volcanic zone of the ridge segment. These fluid lavas are dusted by thin sediment cover, mainly noticeable on flat flows. Also, irregularly shaped lava flows, consisting of accumulations of broken and crushed drapery flow fragments with rough and more lightly sedimented surfaces, are commonly encountered. The freshest samples (dives OT-01 and OT-02) were recovered from the east side of the eastern trough, close to the eastern wall of the rift valley, and consist mainly of aphyric basalt with fresh glassy margins.

Most of the lavas exhibit a thin coating of Fe-Mn oxyhydroxides (<< 0.5 mm) and incipient palagonitization in glass cracks, but occasionally they show fresh glass surfaces. The lava has flowed within a flat, narrow (less than 1 km wide) band and is surrounded by other older and more sedimented sheet flows which have partially buried old disseminated edifices of sedimented pillows. Near the contact with the eastern wall of the valley and the eastern flank of the axial ridge, these sheet flows are bordered by lobate flows

(dives OT-01 and 02), where debris of hydrothermal deposits was observed (dive OT-02) along with shallow collapsed lava ponds with small pillars. This part of the inner valley is devoid of tectonic activity and its original volcanic features are well preserved, while the western trough reveals more heavily sedimented terrains and old fissures in pillow flows underlying the sediment blanket.

The median ridge is an elongated constructional edifice made of sedimented pillows, topped by several conical edifices. The northern part of its eastern flank shows faulted scarps and ancient stockwork deposits at 1900 m depth, where vents of hot white water were observed percolating through circular holes (dive OT-01). Toward the south, the eastern flank is divided into two domains by a single elevated fault scarp covered by scattered patches of ochreous indurated crust made up of brecciated material. The western slope of the median ridge shows smoother topography and thicker sediment cover and the southern end is occupied by sedimented volcanoes made of highly vesiculated pillow-lavas. The shallowest edifice (1600 m) on the southern end is flanked by volcanoclastic deposits (dive OT-03).

The first scarps of the rift valley walls (dives OT-05 and OT-15) show a sediment cover comparable to that of the median ridge, but consist of horst and graben structures with sharp blade-like crests as the result of mass wasting and gravity slumps. Fault scarps are made of sedimented and encrusted pillow sections and massive flows which are often covered by lobate lava. Four off-axis volcanoes explored (dives OT-04, 05, 06 and 07) were found to consist of sedimented old looking volcanics. The volcanoes are conical, built on N-S elongated topographic highs limited by fault scarps. Three of the volcanoes visited are located on the eastern side of the ridge axis, up to 25 km away from it, and one volcano on the western side is located at about 20 km from the axis. Their flanks are gentle sedimented slopes which show variable amounts of rubble and outcrops on steeper slopes. They have flat summits made up of pillows and occasional sheet flows which are altered and encrusted by Fe-Mn coating. From submersible observations, all four of the volcanoes explored consist of similar types of highly vesiculated pillow flows. The detailed magnetic survey shows that the volcanoes have the same magnetic signature as the surrounding oceanic crust, hence they are probably the same age. The youngest volcano (Claire Volcano, dive OT-05), which is the closest to the ridge axis (Figure 3), is terminated by small haystack-like edifices flanked with elongated pillows. The rocks sampled from this volcano have a moderately palagonitized glassy margin. The other volcanoes (Eulalia, Christel and Fara, dives OT-04, 06 and 07), further away from the ridge axis, have an older appearance, less well preserved glass, and thicker sediment cover (> 30%).

The sheet flows are near aphyric to slightly phyric basalt with common olivine and plagioclase microphenocrysts. They contain small (< 0.5 mm) vesicles, often concentrated in parallel layers. Most of

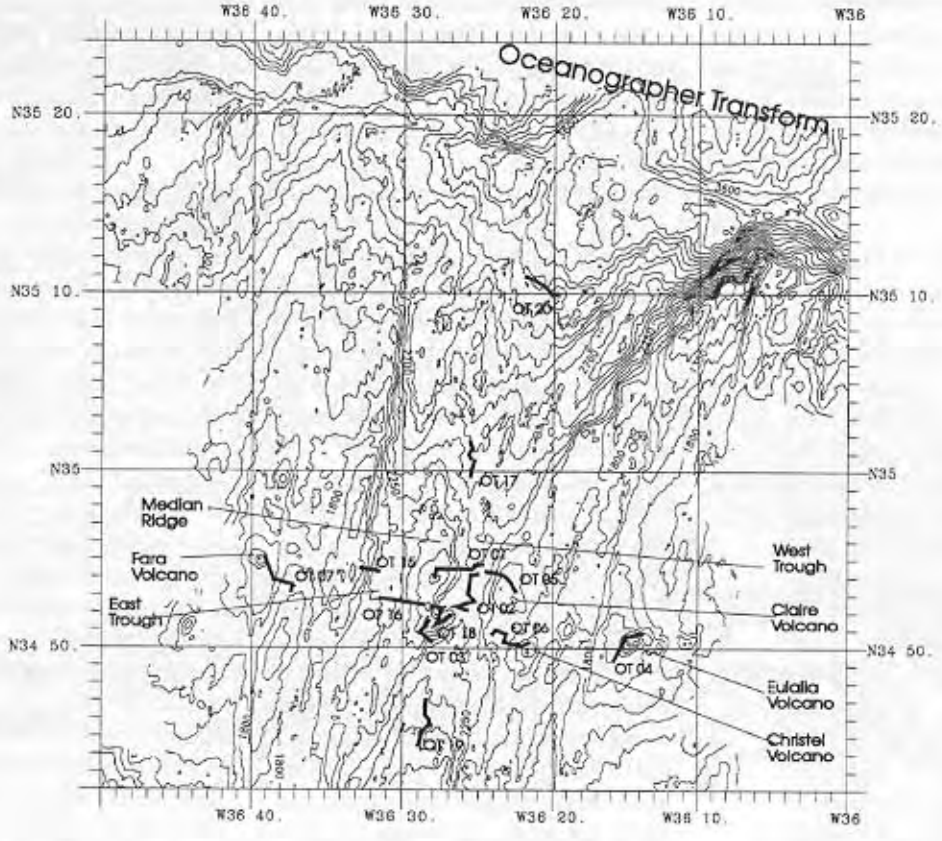

Figure 3. Working area A (segment S1) south of the Oceanographer transform. The locations of the dives are indicated.

the samples collected in the youngest-looking eastern trough exhibit a thin Fe-Mn coating. The pillow flows consist of moderately to highly phyric plagioclase basalts (up to 10% plagioclase crystals up to 1 cm in diameter) with small amounts of olivine phenocrysts (< 5%). The samples from the median ridge, the rift valley walls and the off-axis volcanoes consist of highly vesicular (up to 10-20%) pillow-lavas, with irregular large sized vesicles (often > 5 mm in diameter). The pillow flows which constitute the median ridge and small isolated mounds in the eastern trough appear older than the freshest sheet flows with thicker Fe-Mn coating and palagonite on their glassy margins. The oldest samples were recovered from the volcanoes furthest off-axis and from seafloor surrounding them. They contain abundant clays and iron hydroxides in soft external alteration halos (0.5 to 2 cm thick).

The summit (> 900 m depth) of the oldest (> 2 Ma) volcano (Eulalia, dive OT-04), located at about 22 km east of the median ridge axis, shows very altered basaltic rocks with smooth surfaces, without any Fe-Mn oxy-hydroxide coating nor visible chilled margins. The smooth surfaces are believed to result from the conjugated effects of alteration and abrasion, particularly in the highly vesicular rocks which are more fragile and more easily altered. The erosion of the rocks resembles that resulting from sub-aerial and /or near surface wave action. However, incipient erosion on younger samples, with smooth but preserved Fe-Mn coatings suggests that abrasion by siliceous biological debris transported by bottom currents could provide similar effects over a long period of time (2 Ma), particularly when the rocks are highly vesicular and when their external alteration rim is becoming thicker and softer with increasing age.

The Southern Segment S2 : The inner rift valley of S2 was explored during three dives (OT-09 to 11) located close to the central high (Figure 4) where no median ridge has been constructed during the last 1 Ma. Two dives (OT-12 and 13) were devoted to exploring the first three scarps of the valley walls on both sides of the central high. Two others (dives OT-08 and 14) were focused on topographic highs located near the "inside corner" (active side) of second-order discontinuities which offset the ridge segment to the north and south, as defined by Tucholke and Lin (1994).

As in the northern working area, the more recent lavas were found on the eastern side of the inner floor. These lavas are relatively fresh pillow and sheet flows having a thicker sediment cover than observed on the freshest flows of S1. However, some of the samples of pillow and sheet flows collected during dive OT-11 are the freshest lavas encountered during the cruise, with extremely fresh glassy

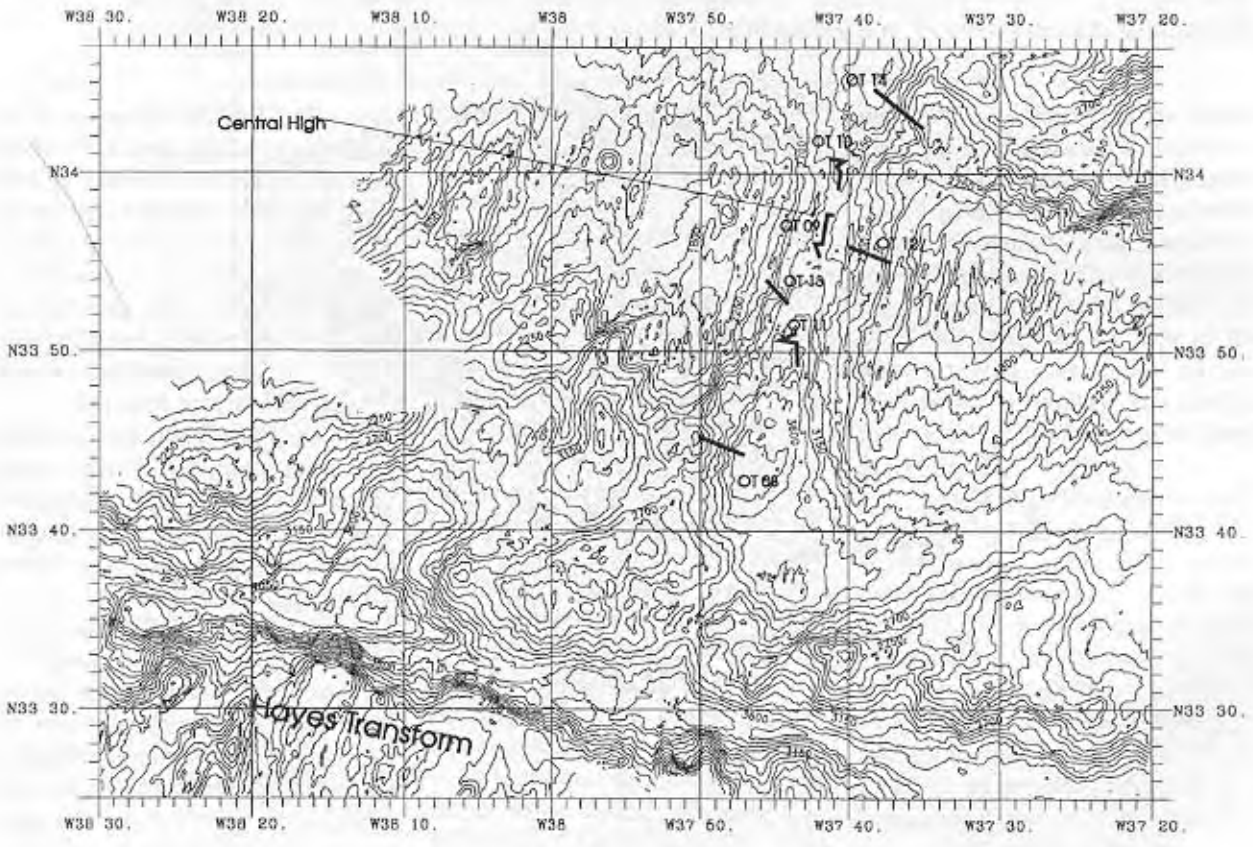

Figure 4. Working area B (segment S2) north of the Hayes transform. The locations of the dives are indicated.

margins. Two of these samples (OT-11-11 and OT-11-12) exhibit joint surfaces coated by reddish hydrothermal deposits. The sheet flows consist of aphyric to slightly phyric basalts, while most of the pillows are moderately to highly phyric plagioclase basalts. The main differences between the pillows recovered from S1 is that the vesicularity on S2 is lower (< 5% spherical vesicles, < 1mm in diameter) and comparable to other MORBs from similar depth (> 2200 m). The southern area is characterized by an abundance of fissures and cracks on both sides of the freshest flows. Fissures are also observed on isolated mounds of pillow flows overlying sheet flows in the inner rift valley. Ancient fissures and conjugated fault-fissures often occur close to the foot of the valley walls. The lowest scarps bordering the rift valley consist of horst and graben structures, with sharp linear crests made up of sedimented terrains and Fe-Mn encrusted pillow sections and massive flows. At several places, faulted outcrops of vertically striated semi-consolidated breccias occur underlying pillow flows. When climbing the rift valley walls, the landscape consists of gentle sedimented slopes with variable amounts of rubble or isolated pillows alternating with talus piles devoid of sediment at the foot of fault scarps.

The topographic highs forming the inside corners of S2 are easily recognizable on the bathymetric map because of their height (about 1000 m) which is about 500 m deeper than the adjacent ridge crests and because of their particular aspect which differs from the general north-south fabric inherited from normal faulting on the ridge flanks. These topographic highs consist essentially of serpentinized peridotites and metadolerites. The ultramafic rocks exhibit fresh orthopyroxenes and are often criss-crossed by small gabbroic and doleritic dykes.

Conclusion

The most recent volcanic and tectonic activities are encountered along a narrow band (< 1km in width) located on the east side of the rift valley floor on both ridge segments explored. Also, the detailed magnetic survey over both the areas studied displays an asymmetrical expansion with a higher rate on the east side. The main distinctive features between the two segments are the following: (1) The central high of S1 has a median ridge, while S2 is devoid of such a structure. (2) The inner valley floor at the central high of S2 is tectonically more active as suggested from the presence of recent horst and graben structures and abundant fissures, while fissures are lacking in the eastern trough of S1. (3) The freshest sheet flows exposed in the eastern trough of S1 have buried isolated pillow-lava mounds, while the freshest flows of the rift valley floor of S2 consist of pillow lavas which overlay the sheet flows.

The median ridge of S1 consists of ancient volcanic edifices made up of highly vesiculated pillow lavas. The observed fissures are sedimented and uncommon, and the main tectonic feature is a fault scarp striking north-south on the eastern flank. However, the number of fissures increases at some distance (5 to 10 km) both to the north and to the south of the central high and highly tectonized terrains occur close to the intersection with the Oceanographer Fracture Zone. Thus, it is likely that the volcanic activity, which was important during the last 1 Ma, is now decreasing on the central high of S1, whereas the magma supply remained low and sporadic during the same period on S2, or it was completely interrupted and it is now in a new phase.

The off-axis volcanoes are ancient edifices showing similarities with the present-day volcanoes forming the median ridge of S1. They probably formed during a period of focused or "pipe" volcanism (Smith and Cann, 1992), which followed the formation of small elongated axial ridges by fissure volcanism. These median ridges and their passively emplaced volcanoes constitute a robust basaltic crust made essentially of pillow flows. Their formation was followed by emplacement of more fluid lava ponds on the adjacent collapsed terrains of the inner floor. Regular spacing (about 10 km) of the seamount groups suggests epidosicity and cyclicity of the magmatic processes. Therefore, the oldest seamounts should have been transported about 20-25 km away from the axis of the S1 ridge segment during the last 2 Ma. Most of the pillows exposed on the median ridge and the off-axis seamounts are comparable and consist of highly vesiculated plagioclase phyric basalts. The top of the seamounts shows more abundant sessile fauna than elsewhere on the surrounding seafloor, probably because of stronger water currents and more oxygenation at lower depth.

The inside corners (Tucholke and Lin, 1994) of the S2 segment where the tectonic activity is prominent are the locus of emplacement of deep-seated serpentinized peridotites by diapirism or detachment faulting. They form massive edifices showing a typical topographic fabric which contrasts with that of the rift valley walls and the ridge flanks. The serpentinized peridotites contain ultramafic relicts and gabbroic and doleritic dykes, forming abundant metagabbro and metadolerite rubble on the slopes.

Acknowledgements

This work was supported by the Department of Marine Geosciences of IFREMER and the Department of Geology of UBO (Université de Bretagne Occidentale) under the sponsorship of the research group GDR-GEDO. We are thankful to the captain, the officers and the crew of the *NO Nadir* as well as to the Nautile team for their help and enthusiasm expressed during the cruise.

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Contrasting Ridge Axis Topography at Australian-Antarctic Ridge

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We conducted a geophysical survey along parts of the eastern margin of the Australian-Antarctic Ridge during the research cruise KH94-4 aboard *RV Hakuho-maru*, 24 November 1994 - 14 February 1995 (Figure 1). The geophysical survey included SeaBeam swath mapping, geomagnetic survey and ship-board gravity measurements. As the principal objective of the KH94-4 cruise was biological research in the Antarctic Sea, a very limited amount of time (about 24 hours) was allocated for geophysical mapping while in transit between the Antarctic Sea and Tasmania. Regardless of limited survey time, we have succeeded in collecting valuable data to show a distinct contrast of the ridge axis topography.

The eastern margin of the Australian-Antarctic Ridge is offset to the south by a large fracture zone which connects it to the Pacific-Antarctic Ridge. A few very short ridge segments are observed between fracture zones.

Figure 2 shows a 3D topographic view of one of such segment along the Tasmania Fracture Zone. The total length of the ridge segment (SB1) is only 30 km. In contrast, Figure 3 shows topography of ridge axis (SB4) where segment length is about 200 km. The two ridge segments show a contrasting topography in spite of being neighbours and having the same spreading rate of 7 cm/yr. Segment SB1 has a clear MAR-type median valley while segment SB4 shows an axial rise similar to the East Pacific Rise. As the Australian-Antarctic ridge regionally shows EPR-type axial topography in this area, the topography of Segment SB1 is rather anomalous. The anomalous ridge axis topography is considered to be caused by insufficient magma supply which is further exaggerated by immature development of mantle plume beneath the ridge. The extremely short length of the segments appears to reduce the size of the mantle plume. Further study of this area will provide us with the opportunity to understand the interaction of the mid-ocean ridge and mantle dynamics beneath it.

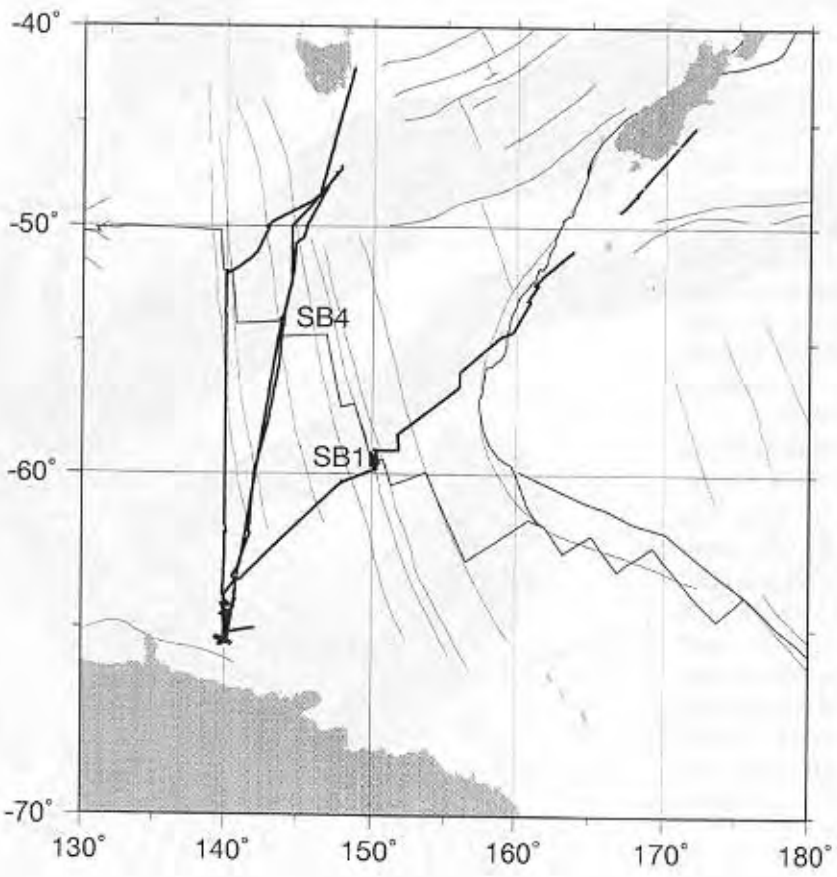

Figure 1: Geophysical ship's tracks of KH94-4 cruise.

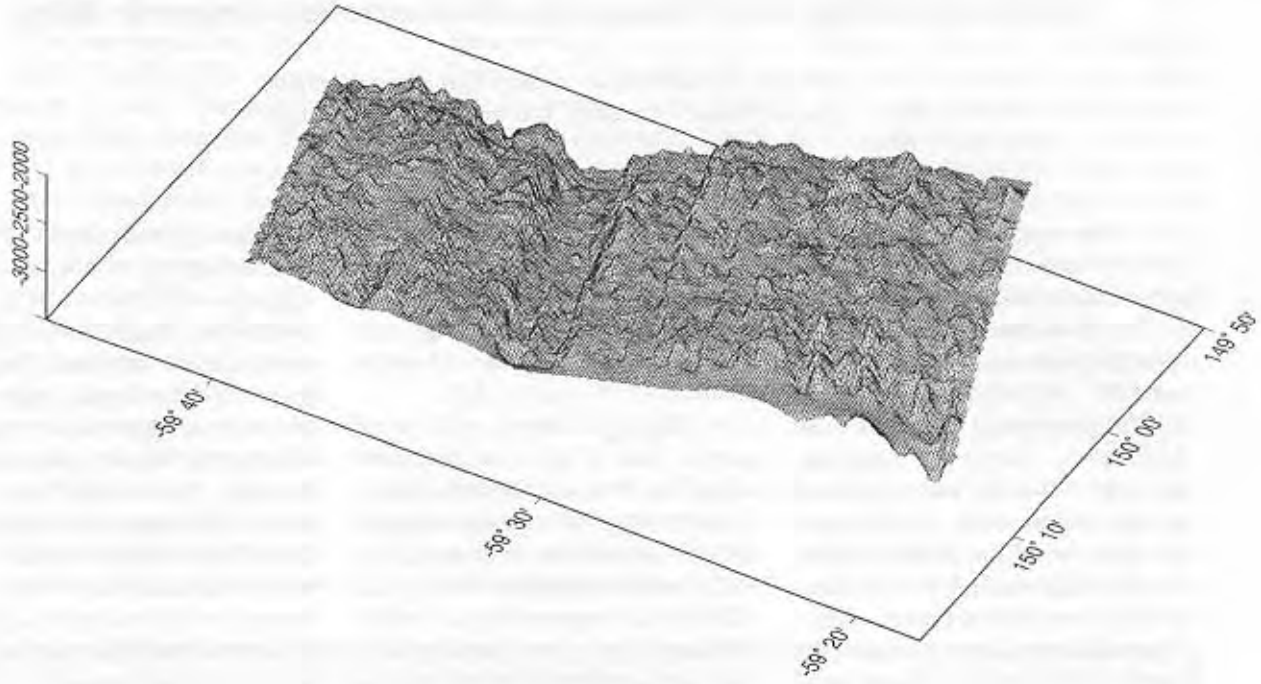

Figure 2: 3D view of ridge axis topography at SB1

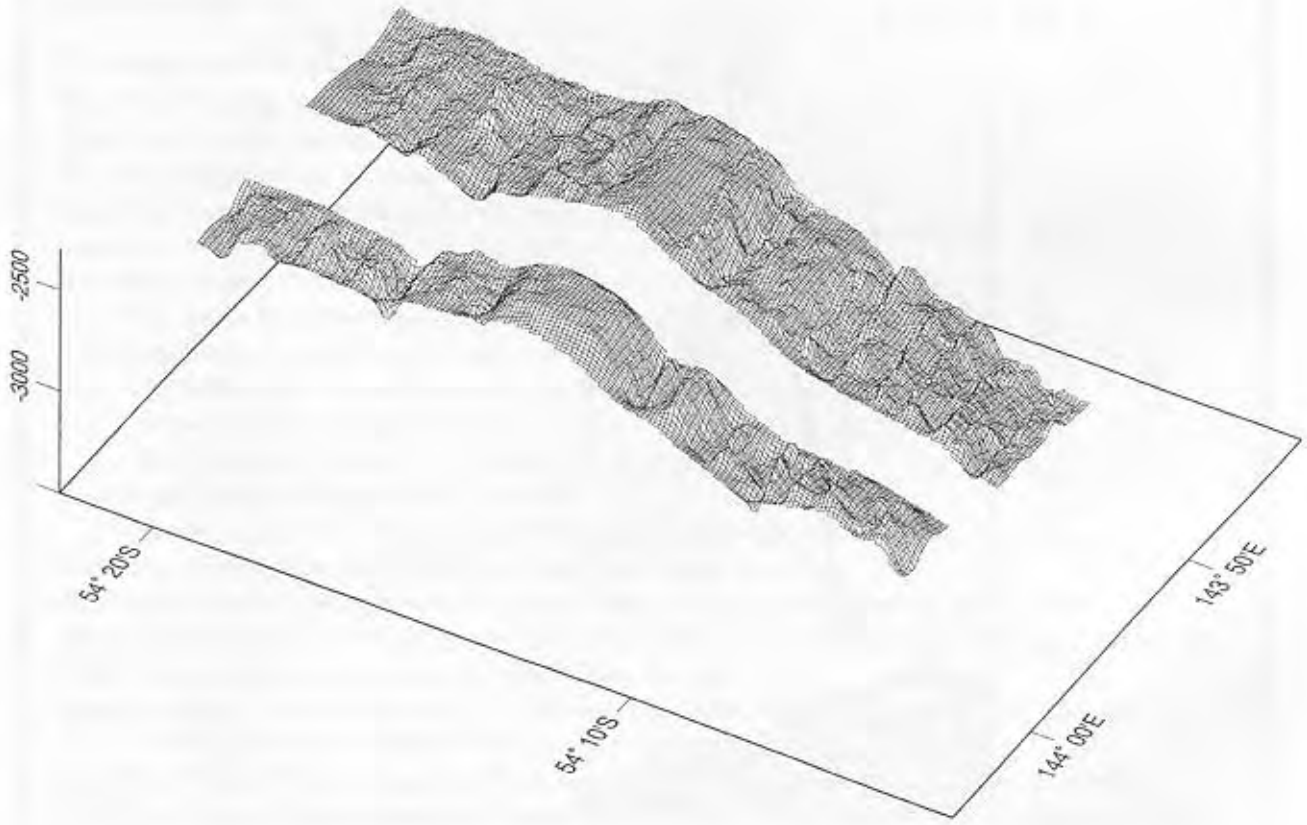

Figure 3: 3D view of ridge axis topography at SB4

Biological Studies at the Ridge Crest

HOT 96: Hydrothermalism and Thermophilic Organisms

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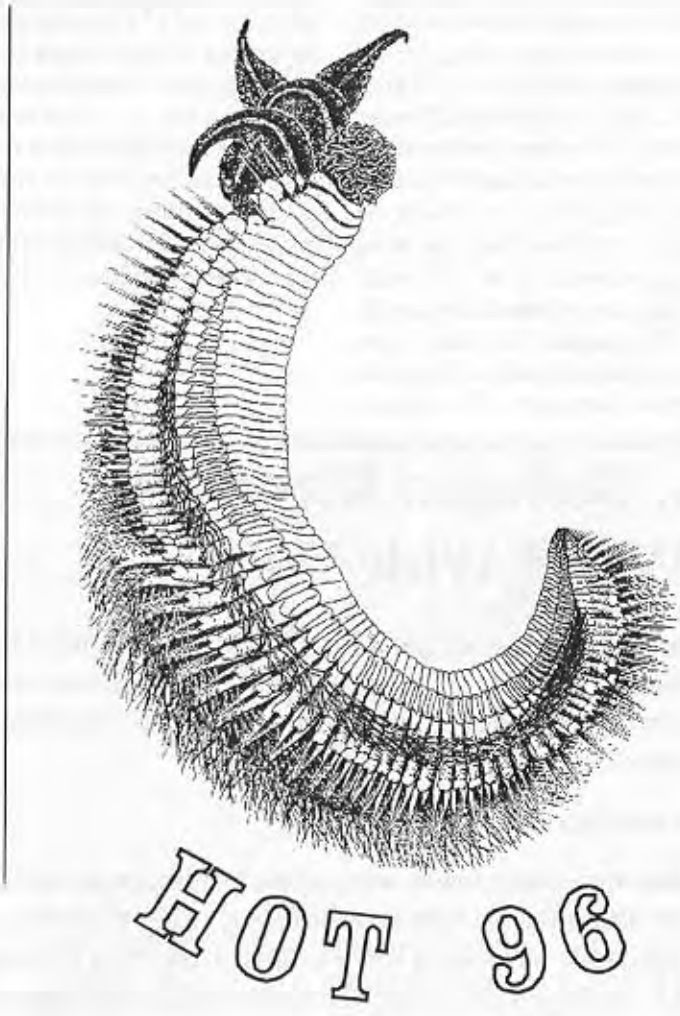
It is now established that the distribution of animal communities associated with hydrothermal vents is related to characteristics of the hydrothermal emission itself. During the last decade, French and American cruises in the Eastern Pacific area have led to a better understanding of the general ecology and ecophysiology of the vent animals, especially those found in areas of diffuse flow, as opposed to other organisms that concentrate around smoker chimneys where higher temperatures are encountered. In this last case, much more remains to be discovered, especially in terms of adaptive mechanisms required for colonising the smokers.

In general, little is known about the strategies that permit colonisation of a given hydrothermal site or about long-range dispersal along the ridge crest. The aim of HOT 96 will be to investigate these strategies, with attention focused on the smoker communities.

The cruise will be carried out on the 9°N (9°45' to 9°52' N) and 13°N (12°53' to 12°57' N) sites of the East Pacific Rise. These sites, which are geographically close, are in different states of evolution and study. Both have been surveyed several times per year, by both American and French submersibles. The general knowledge already acquired (faunistic maps available) will allow us to optimise submersible bottom time (animal collection and in situ experimentation).

This cruise will be undertaken by IFREMER Marine Research Unit N°7 (F. Gaill, chief scientist). The joint presence of an American laboratory ship (H. Felbeck, chief scientist) is an extension of the collaboration between French and American teams, which have already been realised by joint operations (Hydronaut, Hero 91 and 92) and by mutual invitations (Oasis, Galapagos 85, Guaymas 85, MVT 90, Lucky Strike...).



Arctic Mapping

An experiment on the Kolbeinsey Ridge - Jan Mayen Ridge

Contributed by
Rolf Mjelde, Institute of Solid Earth Physics, University of Bergen, Norway
From an abstract by
S Kodaira, Laboratory for Ocean Bottom Seismology, Hokkaido University, Japan

The experiment, carried out during 2-21 May 1995 aboard *RV Haakon Mosby*, involved scientists from the Laboratory for Ocean Bottom Seismology, Hokkaido Univ., Japan (Prof. H. Shimamura, Dr. S. Kodaira, Dr. H. Shiobara), Institute of Solid Earth Physics, Univ. of Bergen (R. Mjelde) and National Energy Authority, Iceland (Prof. K. Gunnarsson).

An extensive seismic survey using Ocean-Bottom Seismographs (OBS) was performed around the Kolbeinsey Ridge, situated between the West Jan Mayen Fracture Zone and the Tjones Fracture Zone to the north of Iceland.

The Kolbeinsey Ridge, whose half spreading rate is 10 mm/yr, is classified as a slow spreading ridge. The OBS data were acquired along three profiles; one profile was situated along the ridge axis (L1) and another 12 km off-ridge (L2) parallel to the ridge strike, and the third profile was perpendicular to the ridge axis (L3). Wide-angle seismic data were recorded by 14 OBS deployed with 12 - 25 km intervals. The crustal thickness is estimated to be 6.8 - 10 km at L1, 8 - 9 km at L3 and 8 - 9.5 km at L3. The crustal models consist of three layers, which are interpreted to be pillow lavas (upper crust), sheeted dykes (middle crust) and the plutonic complex (lower crust). The models indicate lower velocity beneath the ridge axis than in the off-ridge area.

Along L3, we obtained velocities of 2.6 - 3.6 km/s (upper crust), 4.8-6.0 km/s (middle crust) and 6.6-6.9 km/s (lower crust) beneath the ridge axis, while at more than 12 km off-ridge, the model shows velocities of 3.6-4.8 km/s (upper crust), 5.6-6.4 km/s (middle crust) and 6.8-7.2 km/s (lower crust). A velocity difference depending on the propagation direction was found in the upper crust beneath the ridge axis. The velocity in the upper crust along the ridge strike (L1) was estimated to be 14% faster than along the perpendicular profile (L3). The model of L1 also shows significant lateral variation along the axis in the lower crust. The velocity in the lower crust decreases to 6.3 km/s in the southwestern part of L1, where the Moho depth decreases to 7.2 km. The low velocity structure beneath the ridge axis is interpreted as due to high porosity in the upper crust, and higher temperatures, as well as a few percent porosity, in the middle and lower crustal material. According to this interpretation, the crustal model of L3 implies that the cracks have been sealed and the temperatures have decreased to normal in 1.2 Ma - old crust. One possible explanation of the velocity difference in the upper crust along L1 and L3 is anisotropy caused by cracks aligned along the ridge strike direction. The anomalous structure along L1, (i. e., low velocity in the lower crust and shallowing of the Moho), can probably be interpreted as related to the most recent injection processes, or the thermal influence of the Spar Fracture Zone situated 50 km south of the profile.

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This Directory is intended to heighten the profile of biological studies within InterRidge and to facilitate collaboration amongst ridge crest biologists. Each listing contains full contact information and a summary of recent and current work. It can be reached via the InterRidge Home Page at

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If you would like to be listed in the directory, please send us your correct postal address, telephone, fax, e-mail address and a paragraph summarising your research. You may use the form on page 49 of this issue by ticking the Biologist Directory box and enclosing a research summary. All entries on the Ridge Crest Biologist Directory will also be entered on the InterRidge Researcher Electronic Directory.

SWIR Project

The GALLIENI Cruise : A geophysical survey of The South-West Indian Ridge near the Gallieni FZ (37°S, 52°E)

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The *NO L'Atalante* cruise GALLIENI in October 1995 aimed to survey two very different areas of the SWIR on either side of the Gallieni Fracture Zone. While the ultra-slow spreading rate is the same along both sections of the ridge (about 75mm/yr), these differences are shown mainly by the depth (1000m shallower westward), the axis obliquity with respect to the spreading direction (almost 45° east of the Gallieni FZ for only 15° to the west) and the main structural direction (transverse to the east and rather longitudinal to the west).

The scientific objectives were to find out what the effects of these differences are on the geophysical structure of these two areas and, by comparison with the same studies made at the Central MAR, what they

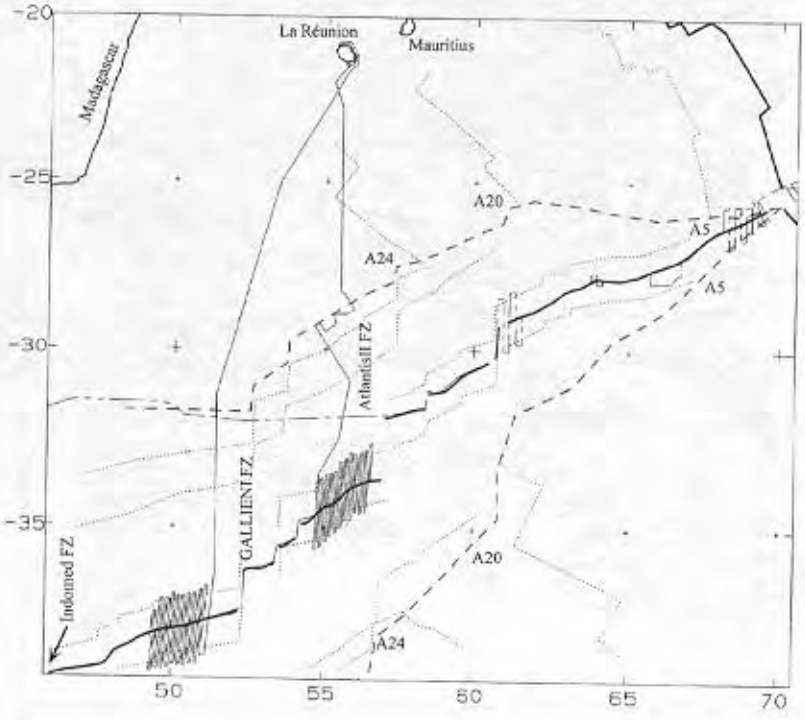

Figure 1. Location of the GALLIENI cruise (*NO L'Atalante*; Sept.-Oct. 95). The profiles (solid line) are spaced 4 miles apart in both boxes. Multibeam SIMRAD bathymetric, gravimetric, conventional and 3 component magnetic, and single channel seismic data were collected along these profiles. The survey of the SWIR axis from Atlantis II FZ to the triple junction is also shown in stippled line for information; it was done by the same ship in April 1993. The triple junction traces within the Africa and Antarctica plates are indicated by the thick dashed line. Location of the axis (bold line) and isochrons (dotted line) A5 (Anomaly 5 epoch), A20 and A24 is also shown.

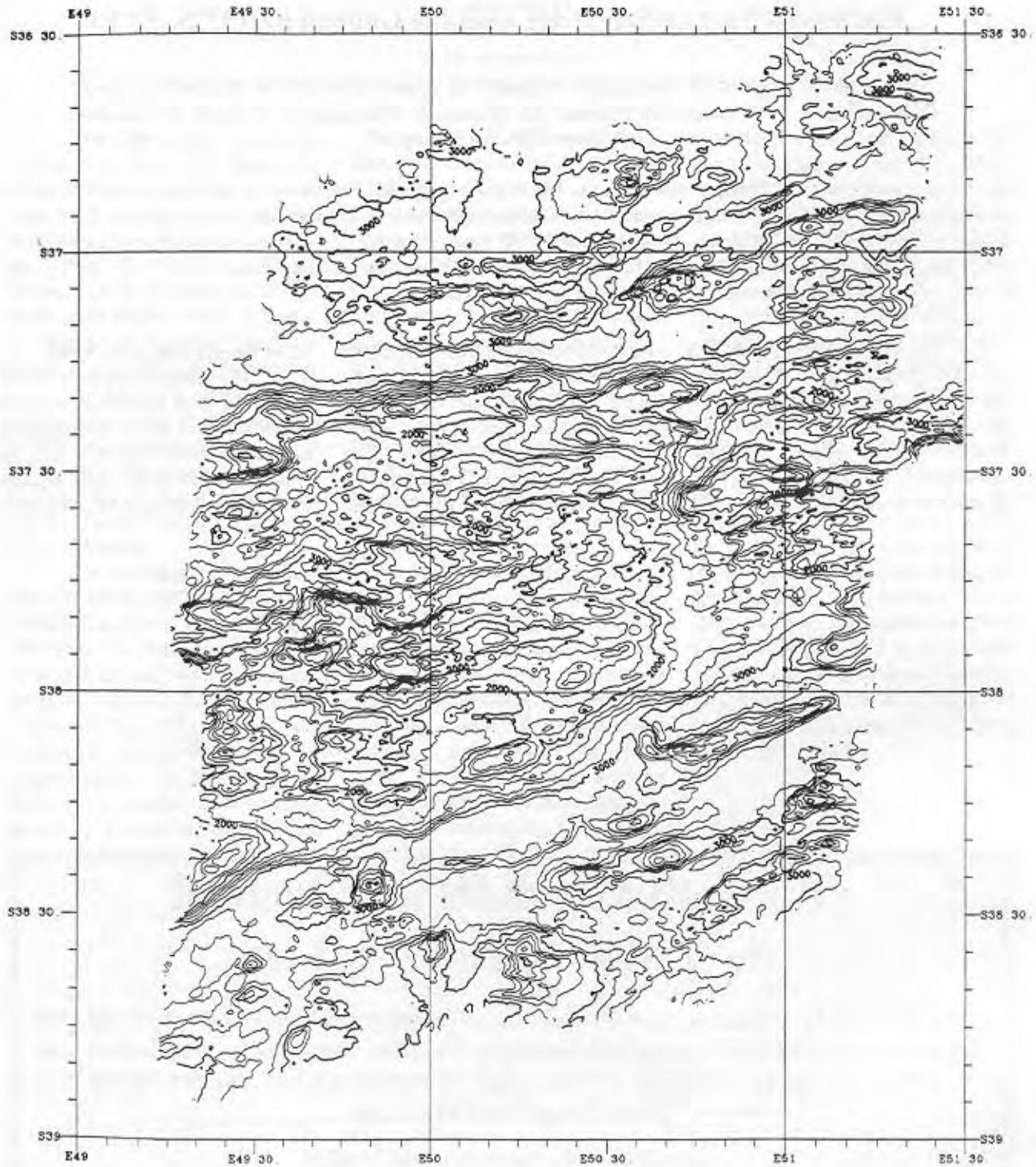

Figure 2a. Contoured bathymetric maps of the boxes (contour intervals 200m, bold line each 1000m): western region.

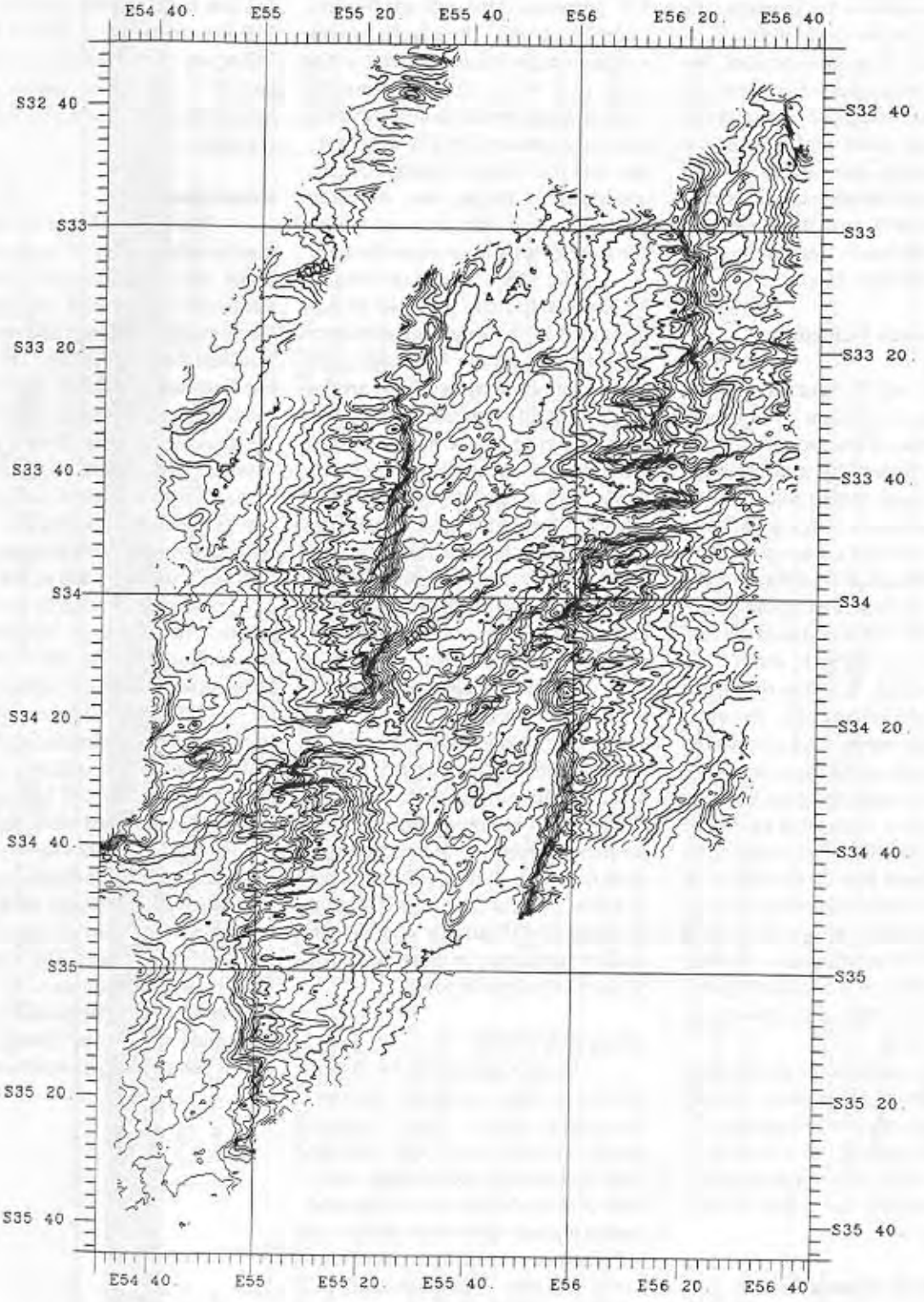

Figure 2b. Contoured bathymetric maps of the boxes (contour intervals 200m, bold line each 1000m): eastern region.

reveal about the signature of the spreading rate.

This survey consists of three parts (Fig.1): a) a detailed survey of a 100km long ridge section located between Indomede and Gallieni FZs, with profiles spaced 4 miles apart, running parallel to the spreading direction out to the 12Ma isochron on either flank; b) another detailed survey of the same type and size between Gallieni and Atlantis II FZs; and c) a 10 mile wide swath profile along the axis, traversing and linking the two boxes, which completes the axis coverage from 49°E up to the triple junction (70°E) begun in 1993 by the same ship (CAPSING cruise).

The Indomede-Gallieni Box. - Figure 2a

The axis is characterized by a deep valley, 6 to 15 km wide, except in the center of the box, where this valley is replaced by a broad high, with numerous conical hills inferred to be volcanoes. Axial offsets thoughout this box are less than 10 to 20 km. Off-axis lows, inferred to be the trace of these discontinuies are sinuous. The central region of the map across the axis and up to about 6 Ma old lithosphere, is distinctly higher than the older lithosphere. The outer limits of this central high are marked by steep, outward facing scarps.

The Mantle Bouguer Anomaly (MBA) map is dominated by a large amplitude low (60 mGal) centered on the shallowest part of the axis. It is bound to the east and west by relative MBA highs that correspond to small offset axial discontinuities. A steep MBA gradient at 6 Ma corresponds to the outward facing scarps seen on the bathymetry.

The magnetic anomalies have high amplitude but outside the central anomaly the identification is ambiguous leading to conjugate isochrons with different geometries. This is probably the result of ridge jumps.

The Gallieni-Atlantis Box - Figure 2b

The most prominent features of this map are the 2 oblique domains of the axial discontinuities, and their deep off-axis traces. These oblique domains accommodate offsets of 50 to 80 km (parallel to the approximately NS spreading direction) and are 60 to 100 km wide (in the EW direction). The axial valley between these discontinuities is deep, narrow (5 to 8 km) and trends EW. These EW portions of the axis are flanked by off-axis highs. These highs present a systematic asymmetry about a NS axis; one flank, that presumably formed at the inside corner of the intersection between the EW ridge portion and the oblique domains of discontinuity, is steeper than the other flank. Conical hills (inferred volcanoes) are present throughout the map.

The MBA map is dominated by lows (amplitude 30 to 40 mGal) elongated in the spreading direction and centered on the EW ridge portions. These elongated lows are S-shaped, the MBA minima being offset to the west on the north flank of the ridge, and to the east on the south flank. This asymmetry appears to be related to that of the off-axis bathymetry: the MBA minima being centered on crust inferred to have formed at the outside corner of intersection between EW ridge sections and the oblique domains of discontinuities. These wide oblique domains correspond to relative MBA highs.

In the magnetics, the main characteristic of this box is the very low anomaly amplitude in the wide oblique discontinuities and even the absence of anomaly in the center of these domains. Over the EW sections and the associated off-axis highs, anomaly identification is easy and the resultant isochrons on either flank can be correctly superimposed.

Along-axis Profile

Three regions can be distinguished on these along axis sections: the central region with 3 fracture zones (offsets 50 to 100 km) displays large bathymetric wavelength variations of about 60 km; the western and eastern regions show larger along-axis bathymetric wavelength variations (about 130 km). The mean depth increases eastwards.

The MBA map shows the expected alternation of lows, centered on EW ridge portions, and highs centered on transform and non-transform discontinuities. The central region has relatively small MBA amplitudes (up to 40 mGal). A very high amplitude low (100 mGal!) is centered on the ridge just west of Gallieni FZ. We don't have complete coverage of this low, but it extends along axis over 110 km, and appears similar to the MBA low of the Indomede-Gallieni box. Thus the western region shows larger MBA amplitudes than the eastern region.

Conclusion

The amplitude and the general map configuration of bathymetry, MBA and magnetic anomalies are strikingly different in the western (Indomede-Gallieni) and eastern (Gallieni-Atlantis) regions. The western (Indomede-Gallieni) shallow region, that has only minor offset axial discontinuities, may have a hotter axial temperature field. Correlatively, overall deeper axial depths in the eastern (Gallieni-Atlantis) region would reflect an overall cooler axial temperature field, probably due to the effect of a "cold-spot" located by the triple junction which may be increased by the cooling effect of the relatively large offset axial discontinuities.

The segmentation wavelengths in the western (Indomede-Gallieni) and eastern (Gallieni-Atlantis) regions are of the order of 130 km, significantly longer than anywhere along the MAR, even though the central region, with many transform/fracture zones, presents segment lengths (around 60 km) similar to the largest MAR segments. If axial segmentation is related to flow dynamics in the asthenosphere, this suggests that these dynamics are distinct beneath the SWIR and the Central MAR.

World Ridge Cruise Schedule 1995-7*

Country	PI	Institution	Name/Location	Research Objectives	Ship	Date
Australia/ Canada	Binns/ Scott	CSIRO Australia/ Univ. of Toronto	**PACMANUS-III**: Eastern Manus Basin, Yuam Ridge Hydrothermal Field	Hydrothermal field study: CTD-transmissometer, dredge, corer, video	Franklin FR09/96	Nov-Dec '96
Australia/ Canada	Binns/Davis/ Scott	CSIRO Australia/ Univ. of Sydney/ Univ. of Toronto	**PACMANUS IV**: Eastern Manus Basin, Bismark Sea, Papua New Guinea	Core drilling to 100m at PACMANUS hydrothermal field with PROD seafloor drill.	Franklin FR09/97	Oct-Nov '97
Canada/ USA	Juniper/ Fisher Delaney	Univ. du Québec/ Penn State Univ.	**BioROPOS 95:** Juan de Fuca Ridge: Endeavour Segment	Biology, hydrothermal vents	J. P. Tully/ ROPOS	July '95
Canada	Edwards/ Scott	Univ. of Toronto	**GeoCanRidge IV:** Southern Explorer Ridge	Rock and bacteria sampling, electromagnetic exp. to survey hi-T vent field	J.P. Tulley/ ROPOS	July '95
Canada	Thomson	IOS	Juan de Fuca Ridge: Endeavour & Coaxial Segments	Hydrothermal plume fluxes biogeochemical links w/ upper water column	Endeavour	July '95
Canada/ USA	Thomson/ Cowen/ Lavelle	Inst. Ocean Sci./ Univ. of Hawaii/ PMEL/NOAA	**ER96**: Juan de Fuca Ridge: Endeavour Segment, CoAxial Ridge, Cascadia Basin	Recovery of two strings of current meters, conventional and inverted sed. traps, bio-acoustic net tows, camera, video, CTD, water chemistry.	J.P. Tully	June '96
Canada/ USA	Juniper/ Fisher/	Univ. du Québec/ Penn State Univ./ U. Washington	**BioROPOS 96**: Juan de Fuca Ridge: Endeavour Segment, Middle Valley	Return visit to biological observatory, survey of massive sulfide	Thompson/ ROPOS	Aug '96
France	Bideau/ Hekinian	IFREMER	**OCEANAUT:** Central North Atlantic	Petrologic and geochemical variations along a slow-spreading ridge	Nadir/ Nautile	Aug-Sept '95

*Archives of the 'World Ridge Cruise Schedule' as published in *InterRidge News* from 1992 onwards are accessible on the World Wide Web via the InterRidge Home Page (http://www.dur.ac.uk/~dg[Ø zz1/).

Country	PI	Institution	Name/Location	Research Objectives	Ship	Date
France	Tapponnier/ Huchon	IPG Paris/ ENS	**TADJOURADEN 1:** Gulf of Tadjoura	Continental rifting, initiation of seafloor accretion	Atalante	Aug-Sept '95
France	Patriat	IPG Paris	**GALLIENI:** Southwest Indian Ridge	Structure and evolution of an ultra-slow spreading ridge	Atalante	Oct '95
France	Prieur	Univ. de Brest	**MICROSMOKE 95:** N. Atlantic, 23°22'N, 45°57'W - Snakepit	Microbiology, hydrothermal vents	Nadir/ Nautile	Nov-Dec '95
France	Deplus	IPG Paris	**SAMUDRA:** Northeast Indian Ocean	Oblique subduction, fossil ridge	Atalante	Nov-Dec '95
France	Géli	IFREMER	**PACANTARTIC:** Antarctic-Pacific Ridge	Geophysics, geochemistry	Atalante	Jan/Feb '96
France/ USA	Gaill	IFREMER/ Univ. Oregon	**HOT 96:** 9°N and 13°N, East Pacific Rise	Hydrothermal activity and thermaphilic organisms, biology	Nadir/Nautile Wecoma	Feb-Mar '96
France	Gente	Univ. Bretagne Occidentale	**TAMMAR:** 22°N, Mid-Atlantic Ridge	Submersible study of mid-ocean ridge segmentation	Nadir/Nautile	Apr-May '96
France	Maia	Univ. Bretagne Occidentale	**FOUNDATION HOTLINE:** Foundation Seamounts, Pacific-Antarctic Ridge	Geophysics, mapping	Atalante	Nov-Dec '96
France	Munschy/ Peznard	EOPG/IMT	**Mai-Mai**: Cocos-Nasca Ridge	Accretionary process and segmentation interaction with hotspot	Atalante	Feb '97
Germany	Devey	University of Kiel	**Poseiden:** Kolbeinsey Ridge, 68.5° - 70°N, Eggvin Bank, S. Mohn Ridge	Bathymetry, rock sampling, geochemistry. Small-scale variation in MORB composition relation between geochemically defined mantle domains and ridge offsets.	Poseidon	July-Aug '96 rescheduled
Germany	Halbach	FU Berlin	**HYDROCK I:** SonneField South Central Indian Ridge	Genesis of massive sulfides and formation of ultramafic rocks	Meteor	Nov '95

Germany	von Huene	GEOMAR Kiel	**ORWELL**: Northeast Pacific	Exploration of the lithosphere: a geophysical experiment	Sonne	Apr-May '96
Germany/ Canada	Herzig/ Suess/ Embley	TU Freiberg/ GEOMAR Kiel/ Univ. Victoria/GSC NOAA	**HYDROTRACE (SO-109)**: Juan de Fuca Ridge: Cascadia Margin, Axial Seamount	Remote vehicle investigation. Tracer distribution and chemical fluxes at hot vents and cold seeps. Biology.	Sonne/ ROPOS	May-July '96 (3 Legs)
Germany	Villinger	UHB	**HYDROCELL**: Northeast Pacific	Hydrothermal circulation in the oceanic crust	Sonne	Aug-Sept '96
India	not available	National Inst. of Oceano./DOD	Central Indian Ridge, 15°-20°S	Mapping regional tectonic fabric, evolution of seamounts	TBA	1995/6
India	not available	National Inst. of Oceanography	Central Indian Ridge	Tectonic & petrologic implications of FZs on crustal generation	TBA	1995/6
India	not available	Geological Survey of India	Carlsberg Ridge	Mapping magnetic anomalies	Samudra Manthan	Jan '96
Japan	Taira/ Ishii	ORI/ Univ. of Tokyo	**KT-95-9:** Mariana Trough	Magnetics survey	Tansei-maru	June '95
Japan	Fujimoto	JAMSTEC/ ORI	**Y95-04**: Mariana Arc, Mariana Trough	Tectonics of the Mariana Arc	Yokosuka	Sept '95
Japan	Urabe	JAMSTEC/ Geological Survey of Japan	**Y95-05 Manus Basin Diving Experiment:** Manus Basin	15 dives, geochemistry, geophysics	Yokosuka/ Shinkai 6500	Oct/Nov '95
Japan	Kinoshita	Geological Survey of Japan	**Ridge-Flux S-EPR:** Southern East Pacific Rise, 13°-18°S	Morphological survey	Gyre/ TAMU[2]	Oct-Dec '95
Korea	Suk/ Lee	Korea Ocean Resh. & Dev. Inst.	East Sea: 37°-37.5°N and 131°-132°E	Geophysical survey SeaBeam 2000, SBP, gravity	Onnuri	Mar '96
Korea	Suk/ Kim	Korea Ocean Resh. & Dev. Inst.	East Sea: 37°-38°N and 130.5°-131.5°E	Geophysical survey SeaBeam 2000, mag., grav., multi-channel seismics.	Onnuri	Sept '96

Country	PI	Institution	Name/Location	Research Objectives	Ship	Date
Korea	Han	Korea Ocean Resh. & Dev. Inst.	**BASAPES-96**: East Sea: Ulleung Basin 37°-38°N and 130°-132°E	Basin structure and past changes in the East Sea. SeaBeam 2000, mag., grav., multi-channel seismics, sed. sampling	Onnuri	Sept-Oct '96 (3rd year)
Mexico/ USA	Knox	Scripps	Middle Americas Trench	Origin and evolution of the Cocos Plate. Multi-beam bathymetry.	R. Revelle	July '96
Russia	TBA -contact Krasnov	Polar Mar. Geo.Exp. Sevmorgeologiya/ VNIIOkeangeol.	**Logatchev - 12**: Mid-Atlantic Ridge TAG Hydrothermal Field, 24.5°N, 15.8°N	Geological mapping, quantative evaluation of massive sulfide deposits, prospecting for new deposits.	Prof. Logatchev	Fall '96 110 days
Spain	Canals	University of Barcelona	**GEBRA-2**: Bransfield Basin Antarctica: Western Antarctica, Pacific Trinity Peninsula South Scotia Sea	Continuing investigation of the Bransfield Basin Swath bathymetry, seismic reflection, gravity magnetics, bottom parametric source	Hesperides	Dec '96- Feb '97
Spain	Dañobeitia/ Córdoba	Inst. de Ciencias de la Tierra, CSIC	**CORTES-96**: Gulf of California Middle Americas Trench	Tectonic evolution of Mexican Cont. Margin and Gulf of California	not available	1996/7
Spain	Dañobeitia	Inst. de Ciencias de la Tierra, CSIC	Galapagos Swell	Geophysical reconnaissance along a segment of the Galapogos Swell	not available	1996/7
United Kingdom	Murton/Dixon/ German/ Herring	IOSDL/ PML	**FLUXES I:** MAR 29°N Broken Spur hydrotherm. site	Integrated fluxes experiment	Ch. Darwin/ BRIDGET/ SHRIMP	Aug/Sept '95
United Kingdom	Sinha/ Peirce	Univ. of Cambridge/ Univ. of Durham	Lau Basin: Valu Fa Ridge	Geophysics: Electromagnetics, wide angle seismics using OBSs	Ewing	Nov-Dec '95
United Kingdom	Searle/ Mitchell/ Cowie	Universities of Durham and Edinburgh	**CD99**: Mid-Atlantic Ridge, 29°N axial segment	Quantification of total strain in a single spreading segment. Deep-towed side-scan and multi-beam sonar, 3-component magnetics.	Charles Darwin/ TOBI	Mar-Apr '96
United Kingdom	Cann/ Blackman	Univ. of Leeds	**CD100**: Mid-Atlantic Ridge Segment south of Atlantis FZ	Determine strain from strain indicators near ridge-transform intersection. Test low-angle serpentinite landslide zone vs. fault scarp model. New TOBI inst. package, dredge.	Charles Darwin/ TOBI	Apr-May '96

United Kingdom	Murton/ Palmer	Southampton Oceano. Cen/ Univ. Bristol	**CD102:** Mid-Atlantic Ridge: 26°N and 29°N	Hydrothermal sediment processes at TAG and recovery of FLUXES I instruments	Charles Darwin/ BRIDGET/	Sept '96
USA (RIDGE)	Spiess	Scripps Inst. of Oceanography	Juan de Fuca Ridge	Seafloor strain measurements	not available	94/95/96
USA	Embley/ Tivey	PMEL/ WHOI	Juan de Fuca Ridge	Hydrothermal vent survey, 12 dives	Atlantis II/ Alvin	June-July '95
USA	Fisher	TAMU/ODP	Gorda & Juan de Fuca Ridges	Coring	Ewing	June-July '95
USA (MG&G)	Tivey/ Becker	WHOI/ Univ. of Miami	Juan de Fuca Ridge	Magnetic polarity boundary, 12 dives	Atlantis II/ Alvin	July '95
USA (MG&G)	Mottl	University of Hawaii	Juan de Fuca Ridge	Off-axis hydrothermal venting, 16 dives	Atlantis II/ Alvin	Aug '95
USA (RIDGE)	Johnson/ Delaney	University of Washington	Juan de Fuca Ridge	Coaxial eruption response and time dependent changes in young crust, 22 dives	Atlantis II/ Alvin	Aug-Sept '95 (2 legs)
USA	Macdonald	Univ. of Calif. Santa Barbara	South Pacific	SeaBeam survey	Melville	Sept-Oct '95
USA	Haymon	Univ. of Calif. Santa Barbara	East Pacific Rise, 17°-18°N	AMS-120 mapping, sampling	Melville/ ARGO II	Oct-Nov '95
USA (MG&G)	Batiza	University of Hawaii	East Pacific Rise, 13°N	Hyaloclastites, 9 dives	Atlantis II/ Alvin	Oct-Nov '95
USA (RIDGE)	Forsyth/ Chave et al.	Brown University/ WHOI	**MELT**: East Pacific Rise	Electromagnetic and seismic experiment	Melville	Oct-Nov '95
USA (MG&G)	Lonsdale/ Hawkins/ Castillo	Scripps Inst. of Oceanography	Pacific-Antarctic Ridge	Off-axis to origin, SeaBeam, dredging	Meville	Nov-Dec '95

Country	PI	Institution	Name/Location	Research Objectives	Ship	Date
USA	Lutz/ Lilly/ Cary	Rutgers/ Univ. Washington/ Oregon State Univ.	East Pacific Rise, 9°-10°N, 13°N	Hydrothermal vent biology, 19 dives	Atlantis II/ Alvin	Nov-Dec '95
USA	Mullineaux/ Walden	WHOI	East Pacific Rise, 9°-10°N	Hydrothermal vent biology, 19 dives	Atlantis II/ Alvin	Dec '95
USA	Cande	Scripps Inst. of Oceanography	South Tasman Sea	Geophysics	Ewing	Jan-Feb '96
USA (RIDGE)	Grindlay/ Madsen et al.	Univ. Porto Rico/ Univ. of Delaware	Southwest Indian Ridge, 15°E to 35°E	Geophysics	Melville	Feb '96
USA	Taylor	SOEST, Univ. of Hawaii	**MW9603**: Lau Basin: 17°-18.6°S, 174.3°-178°W Central Lau Spreading Center ETZ - Peggy Ridge	HMR1 & MGG Survey of back-arc basin rifting and spreading.	Moana Wave	Feb-Mar '96
USA	Johnson/ Scheirer/ Graham/ Forsyth	Bishop Museum/ Brown Univ./ Oregon State U.	**Boomerang - Leg 6**: SEIR 77°-90°E, St. Paul/Amsterdam Hotspot	SeaBeam, dredging, wax coring, gravity, magnetics.	Melville	Feb-Apr '96
USA	Chave/Stein/ VanDover/Cary/ Cavanaugh/ Ravizza	WHOI/ Univ. Alaska/ Univ. Deleware/ Harvard Univ.	**AII/Alvin**: East Pacific Rise, 9°-10°N, 13°N	Hydrothermal vent biology. 14 dives, light measurements, biological and water sampling	Atlantis II/ Alvin	Apr '96
USA	Michael/ Hanan	Univ. of Tulsa/ San Diego State U.	**SMARTS**: Southern Mid-Atlantic Temporal variation Study: 32.5°-33.5°S, axis to 7 Ma.	Determine temporal variation of mantle composition and extent of melting.	Knorr	Apr-May '96
USA	Cannon	PMEL/NOAA	**Kodiak-Seattle Transit**: Juan de Fuca Ridge: Cleft Segment	Current meter mooring recovery	Discoverer	May '96

USA	Karson	Duke University	Hess Deep	Geology, 20 dives	Atlantis II/ Alvin	May-June '96
USA	Chave/ Dorman	WHOI/ Scripps	**MELT II**: East Pacific Rise at 17°S	Deploy magnetotelluric array of 60 instruments	T. Thompson	May-June '96
USA	Baker/Cannon/ Freely/Lupton/ Massoth	PMEL/NOAA	**VENTS 1996 Leg 1**: Juan de Fuca	Plume survey and water sampling for hydro-thermal acctivity; mooring deployment and recovery	Discoverer	June '96
USA	Fornari/ Humphris/ Langmuir/ Van Dover	WHOI/ LDEO	**Lucky Strike-Jason/ARGO II-120 kHz Sonar**: Mid-Atlantic Ridge 37°18'N	Mapping and sampling of the Lucky Strike Hydrothermal Field.	Knorr	June-Aug '96
USA	Tucholke/ Kleinrock/ Lin	WHOI/ Vanderbilt Univ.	**Eastern Mid-Atlantic Ridge Flank Survey:** 26°N	Mapping of 400 x 200 km box centered near 26°N. Segment history, spreading asymmetry, episodicity	Ewing	July-Aug '96
USA/ UK	Klinkhammer	Oregon State University	Mid-Atlantic Ridge	Hydrothermal venting, 16 dives	Atlantis II/ Alvin	Aug-Sept '96
USA	Speiss/ Hildebrand/ Chadwell/ Zumberge	Scripps	Juan de Fuca Ridge: Cleft Segment, 48°10'N, 127°10'W	Seafloor geodesy, revisit precision benchmark transponders & absolute gravity reference points, testing installation of fiber optic strain meter. Seafloor strain measurements, plate motion.	unknown	Aug-Sept '96
USA	Macdonald/ Scheirer/ Cormier	UCSB/ Brown Univ./ LDEO	East Pacific Rise: East Flank 15°-21°S	SeaBeam 2000 mapping gravity, magnetics	Melville	Sept-Oct '96
USA	Haymon/ Macdonald	UCSB	East Pacific Rise: Axis 17°-18°S	JASON/ARGO II, AMS 120, hydrothermal/ tectonic studies	Melville	Oct-Nov '96
USA (RIDGE)	Detrick	WHOI	Mid-Atlantic Ridge, 34°-37° N	Seismic experiment	Ewing	Oct-Nov '96

News from Ridge Research and Related Programmes

Australia

The Australian InterRidge community, despite their lack of a suitable research vessel which would enable them to contribute to major InterRidge related projects, are very active in collaborative projects with overseas researchers and as participants in the Ocean Drilling Program. Research activities encompass geochemical, experimental and theoretical studies of magma genesis at spreading ridges, geophysical and geodynamic studies of ridges and the origin of hydrothermal seafloor systems. Current activity in these areas is briefly summarized below:

Geochemistry of mid-ocean ridge basalts (MORB)

i) H_2O geochemistry

Leonid Danyushevsky (UTasmania) has completed a major study on the H_2O geochemistry of MORB based on ~400 glasses. The study focuses on the identification of possible independent components involved in MORB petrogenesis which are responsible for the observed variations of H_2O/(other incompatible element) values in depleted MORB.

ii) Source compositional controls on mantle melting and melt production

Yaoling Niu (UQueensland) is involved in a number of collaborative projects with overseas researchers focusing on the MAR 33° to 35°N (Hékinian, Bideau, Batiza), the Hump area 18° to 19°S of the East Pacific Rise (EPR; Sinton, Mahoney), near-ridge seamounts N. EPR (Batiza) and the Pacific-Antarctic Ridge (Castillo, Natland).

iii) Southern Ocean basalts

Tony Crawford and Rick Varne (UTasmania) have recently been awarded an Australian Research Council grant to work on the petrogenesis of the rocks on Macquarie Island, an upthrust section of oceanic crust on Macquarie Ridge at the eastern end of the Southern Ocean. New mapping of this island by geologists from Mineral Resources Tasmania has clarified relationships between the lavas and the intrusive and mantle sections (including mantle harzburgites) and 5 new 1:50,000 maps will be produced covering the entire island. An extensive new sample set includes more that 100 basaltic glasses, and numerous picritic lavas. Related to this project Dima Kamenetsky and Stephen Eggins are using laser ablation ICPMS to determine trace element contents of Maquarie Island matrix glasses and melt inclusions.

Melt inclusion studies

The University of Tasmania has a fully-equipped heating stage and microscope allowing real time observation of homogenization of melt inclusions in early-formed crystals (olivine, spinel, plagioclase, clinopyroxene). The homogenized melt inclusions can then be analysed for major and trace element contents to characterize the nature of parental and primary spreading ridge magmas. Studies relevant to the InterRidge community using this technique are:

i) SEIR primary magma variations

Leonid Danyushevsky was a recent participant on the *RV Melville* Westward Leg 10 in the Southern Ocean along the Southeast Indian Ridge (SEIR) from ~89°E to ~118°E in February 1995. In collaboration with Brendan Sylvander and David Christie (Oregon State University, Corvallis) he is using the melt inclusion technique to determine primary melt composition changes along the SEIR.

ii) ODP Leg 148

Andrew McNeill, a PhD student at the University of Tasmania, has recently completed a study of 896A basalts using the heating stage techniques demonstrating that primary melts arrived from at least 1.8-2.0 GPa and ~1400-1450°C in the mantle, and that high An (An ~94) plagioclases in this suite crystallized from relatively evolved (~15% olivine-only crystallization) melts in equilibrium with olivines Fo86-87 (cf 91.5 in the most magnesian olivines). As well, the compositions of these primary melts have been experimentally tested by peridotite reaction experiments (T. Falloon) which confirm that the inferred primary magma compositions are capable of equilibrium with an upper mantle assemblage. The trace element content of the melt inclusions has been determined using both ion-probe (J. Blundy, UBristol) and laser ablation ICPMS (S.M. Eggins, ANU) techniques.

iii) Lau Basin - Valu Fa Ridge

Kamenetsky and Crawford (UTasmania) in collaboration with R Muhe (Univ. of Kiel) have recently finished a study of melt inclusion compositions in primitive olivine phenocrysts hosted by primitive basalts from seamounts located ~8km either side of the propagating tip of the Valu Fa spreading center in the Lau Basin. The melt inclusion study demonstrates the existence and mixing of very refractory boninite-like magmas with high CaO (~14%) basaltic magmas. These distinctive magma types are both inferred to be the result of the propagation of the Valu Fa spreading center into a veined hydrated sub-arc lithosphere. The identified magma types show strong affinities to lavas drilled by ODP Leg 135 site 839, and a similar process is proposed for the production of these lavas (the propagator in this case being the Eastern Lau Spreading Center at ~2-3Ma).

Petrology and Lithostratigraphy of the oceanic crust at mid-ocean ridge spreading centers

i) Petrogenesis of abyssal peridotites

Yaoling Niu (UQueensland) is involved in two collaborative projects on abyssal peridotites, first with Charlie Langmuir on published literature data, and with R. Hékinian on peridotites from the Garrett Transform. In both projects the abyssal peridotites will be investigated to extract information on melting processes beneath spreading ridges.

ii) ODP Leg 147

Trevor Falloon (UTasmania) was a participant on the Ocean Drilling Program Leg 147 to the Hess Deep, equatorial Eastern Pacific and is continuing his research on the gabbros and peridotites from site 895.

iii) ODP Leg 153

Chris Stephens (Queensland Univ. of Technology) was a participant on the Ocean Drilling Program Leg 153 to the MARK area MAR. Chris' research is mainly focused on the geochemistry and mineralogy of oceanic peridotite and gabbro and its implications for melt/mantle interaction below slow spreading ridges.

Experimental and theoretical studies of mantle melting

i) Compositions of low degree mantle melts

The compositions of low degree partial melts are essential information for erecting and testing models of melt extraction by porous flow and melt pooling during mantle upwelling under spreading ridges. Trevor Falloon (UTasmania), David Green, Hugh O'Neill and Bill Hibberson (Research School of Earth Sciences, Australian National University) have recently completed an experimental study at 1 GPa demonstrating that low degree anhydrous melts are basaltic with ~15-20% normative diopside, >10% normative olivine, have high Na_2O and K_2O contents and are nepheline-normative. This study also examined the compositions of melts in equilibrium with extreme (i.e. unrealistic) mantle compositions (eg. an albite bearing harzburgite residue). Such melt compositions are important in mapping out the compositional boundaries of mantle melting. These studies will be extended both to higher and lower pressures relevant to melting processes under spreading ridges.

ii) Experimental testing of published peridotite melt compositions

Trevor Falloon (UTasmania) is involved in a number of collaborative projects aiming to test by compositional reversals published experimental melt compositions from melting studies on mantle peridotite relevant to melting processes under spreading ridges. Published compositions currently undergoing experimental tests include compositions from diamond-aggregate-extraction experiments (in collaboration with Green, O'Neill and Hibberson) and compositions from published 'sandwich' or peridotite-reaction experiments (in collaboration with Ro Kinzler, LDEO, and Timothy Grove, MIT). Such experimental tests are necessary to confirm the reliability of data used in developing quantitative models of mantle melting.

ii) Equilibrium phase relationships of MORB pyrolite to 10GPa

Greg Yaxley (Research School of Earth Sciences, Australian National University) is currently studying the phase relationships of a MORB pyrolite composition from 4-10GPa using a multi-anvil apparatus, with improved heater design and novel capsule techniques (FeIr, Olivine) to eliminate thermal gradients and control fO_2 and eliminate Fe-loss. This study will be important in helping to understand melting process associated with deep upwelling beneath spreading ridges.

iii) Equilibrium melt distribution in the mantle

Uli Faul (Research School of Earth Sciences, Australian National University) has recently completed a study on the permeability of partially molten upper mantle rocks. Experiments with olivine and a basaltic melt demostrate that most of the melt resides in low aspect ratio, disk-shaped inclusions on two-grained boundaries at melt contents from 0.75 to 3.2 vol. %. Triple junction tubules are much smaller than the disk-shaped inclusions and contain less than 0.15 vol.% melt, independent of the total melt fraction. The permeability of the triple junction tubule network only is low ($k^2$10-17 m^2) and segregation velocities are less than one millimeter per year. The permeability of the aggregate increases substantially only after the disk-shaped inclusions become interconnected, and this does not occur until the melt fraction reaches 2-3 vol%. The results of this study have important implications for mantle melting processes. Uli Faul is now extending this study to investigate an aggregate with two pyroxenes present in addition to olivine. Pyroxenes are less wetted by the melt, so that olivine grains might have a higher proportion of the total melt fraction associated with them. This would lead to further modification of the

permeability of partially molten upper mantle.

Martin Cmiral, a PhD student at the RSES, will be studying the effect of differential stresses in enhancing porous flow at low melt fractions. This study will use experimentally hot-pressed olivine+basalt powders which will then be subsequently deformed using apparatus in the Petrophysics Group at the RSES.

iv) Theoretical melting models

Stephan Klemme and Hugh O'Neill (Research School of Earth Sciences, The Australian National University) have started work on developing a thermodynamic model of mantle melting.

Geophysical Studies of Ridges

i) MELT experiment East Pacific Rise

Graham Heinson and Antony White (Flinders Univesity) are both currently involved in the MELT experiment to the East Pacific Rise 17°S, as part of the US RIDGE program. Flinders University will be supplying 8 sets of magnetotelluric instrumentation to be deployed by *the RV Thomas Thompson*. Their research is seeking to detect molten rock in the crust and asthenosphere beneath ridges.

ii) Geodynamics of the Pacific and Australian plate boundary

Papua New Guinea lies at the boundary of the Pacific and Australian plates. The tectonics in this area are characterised by a mosaic of small plates, moving and deforming in response to overall convergence between the major plates. The region contains crustal subduction, crustal spreading, transform faulting and broad diffuse deformation zones.

Kurt Lambeck, Paul Tregoning and H. McQueen (Geodynamics Group, RSES, ANU) will be conducting a GPS survey spanning most of the minor plates in August/September 1996 in conjunction with the National Mapping Bureau (NMB) of PNG. This is a followup of earlier GPS work by the University of NSW and NMB. The study will produce a determination of the direction and magnitudes of the motions across the subduction zones and spreading centres of the microplates and lead to a better characterisation of the interplay between these zones.

Magmatism in back-arc basins

The Australian InterRidge community is very active in the petrology of back-arc basin magmatism and its relationship to the tectonic setting of the local environment. Studies, predicably, are concentrated in the tectonically complex Southwest Pacific. Studies currently undertaken by Australian researchers are focused on the following areas

i) North Fiji Basin

Leonid Danyushevsky (UTasmania) was a participant on the ProFeTi cruise of ORSTOM *RV Alis* in November 1994 which surveyed and sampled the ~18°S propagating rift in the center of the Basin. The samples from the propagating rift all have NMORB geochemistry, and are currently being studied in collaboration with J.P. Eissen and C. Fleutelot (ORSTOM, Brest).

ii) Lau Basin

Australian researchers were well represented on the very successful ODP Leg 135 to the Lau Basin and participants Janet Hergt (University of Melbourne) and Tony Ewart (University of Queensland) are continuing their studies on material from this Leg. Tony Ewart is currently collecting more detailed trace and isotope (Sr, Nd, Pb and U series) data on the Lau samples to investigate regional patterns of mantle source depletion. This work is being done jointly with Ken Collerson, Marcel Regelous and Immo Wendt (UQueensland). Janet Hergt in collaboration with Stephen Eggins (Australian National University) is analysing Lau Basin glasses for B and Be abundances, to investigate the possible subduction zone influence on the composition of magmas erupted at backarc spreading centers. Trevor Falloon (UTasmania) is continuing his research on samples recovered during the 1990 cruise of the *Keldysh* as well as conducting experimental studies on primitive Lau Basin compositions in collaboration with James Hawkins (Scripps Oceanographic Institute).

iii) Vanuatu

With Richard Price (Latrobe U), Stephen Eggins (Australian National University) and French colleagues from ORSTOM (Brest), Tony Crawford (UTasmania) continues work on the petrogenesis of lavas in the embryonic backarc basins in the Vanuatu island arc, and also from the older sections of the North Fiji Basin.

iv) Woodlark Basin

Danyushevsky and Crawford (UTasmania) have completed a detailed study of three basaltic suites from the Woodlark Basin dredged during the 1987 Papatua cruise (SIO, Chief Scientist H. Craig).

Seafloor hydrothermal systems

i) Eastern Manus Basin - Papua New Guinea

Australian researchers Binns, Parr, Waters (CSIRO, Division of Exploration and Mining) and Gemmell (UTasmania) are very active in studying seafloor hydrothermal activity and its tectono-volcanic setting in backarc environments near Papua New Guinea. The program (in collaboration with Scott and Moss, University of Toronto) focusses on the eastern Manus Basin, an area of rifted arc crust rather than seafloor spreading, and especially on the dacite-hosted PACMANUS hydrothermal field with several sites of Cu-Zn-Au-Ag rich sulfides. Forthcoming cruises

with the Australian research vessel *RV Franklin* include:

1) Cruise FR9/96, November-December 1996; further sampling and photography at PACMANUS and a similar field nearby; search for the source of a plume detected 40km to the east in 1993; reconnaissance surveys elsewhere in the Manus Basin.
2) Cruise FR9/97, October-November 1997; shallow drilling below PACMANUS and vicinity with a small sea-floor drill.

ii) ODP Leg 158

Bruce Gemmell (UTasmania) has recently returned from Ocean Drilling Program Leg 158 which successfully drilled the active, MORB-hosted, TAG hydrothermal mound on the Mid-Atlantic Ridge. Bruce will be studying the sulphide mineralogy and the sulphur isotope geochemistry.

iii) ODP Leg 169

Rowena Duckworth (James Cook University) will be participating on the forthcoming Ocean Drilling Program Leg 169 (Sedimented Ridges II) which is designed to investigate the large scale hydrogeology of Middle Valley, the formation of massive sulphide deposits, the fine-scale hydrogeology of hydrothermal vent fields, and the formation of oceanic crust under sediment-covered spreading centres. The Leg will drill sites at Middle Valley (Juan de Fuca Ridge) and in the Escanaba Trough (Gorda Ridge).

iv) Transition metals in MORB

Yaoling Niu (UQueensland) is involved in a collaborative project (Batiza, Sinton, Hékinian) on the systematics of transition metals in MORB and mineralization potential.

v) Pb-isotope compositions of sulphide ores

Janet Hergt (UMelbourne) in collaboration with Chris German is studying the Pb-isotope composition of sulphides from the TAG area of the MAR and EPR to understand the source of the sulphur in these deposits.

vi) Au-Cu metallogenesis at convergent margins

Brent McInnes (Magmatic-Hydrothermal Systems Group, CSIRO Division of Exploration and Mining, Sydney) is studying a suite of ultramafic, mafic and sedimentary xenolith samples from a shoshonitic, hydrothermally active/mineralized, cinder cone located near Lihir Island in the New Ireland fore-arc basin, Papua New Guinea. The xenolith samples provide a unique insight into the nature of mantle wedge peridotite (ancient Pacific plate generated at a major mid-ocean ridge spreading center) and the processes of hydro-fracturing, alkali hydration metasomatism, and oxidation as consequences of dewatering of the subducted slab.

The Australian correspondent wishes to apologise in advance to anybody who has been left out of this report and requests that they contact him so they can be included in any subsequent reports.

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The InterRidge Office is currently accepting submittal of articles for the next issue of *InterRidge News* to be published in October 1996.

InterRidge News is intended for rapid publication of preliminary results and cruise reports which do not appear in other publications. Ridge crest researchers are encouraged to submit their findings as short articles:

1-4 manuscript pages with up to 3 figures.

Appropriate topics include:

- preliminary results of ridge crest cruises, particularly involving multi-national co-operation
- technical or engineering developments capable of enhancing ridge crest investigations.

Submission:

- Prefered submission method/format is by e-mail to intridge@durham.ac.uk as an attached RTF file. Originals or good quality reproductions of figures may be sent by post or ftp.
- Reference style **must** conform to references appearing in this issue.

Articles must arrive in the InterRidge Office no later than 25 September 1996.

BRIDGE

THE BRITISH MID-OCEAN RIDGE INITIATIVE

In December 1995 BRIDGE received proposals for funding in its fourth (and final) funding round. During the three previous rounds BRIDGE has supported 40 research projects submitted by 57 investigators from 20 UK research institutions. A total investment of £7.6 M has been committed to these existing awards. The fourth round applications are currently being assessed and the results of the round will be available later in the year.

In addition to a general Announcement of Opportunity, applications had been invited from UK researchers particularly interested in using manned submersible facilities as part of their study. This was a response to observations made during the year that biologists investigating mid-ocean ridges have been under-represented in previous submissions for BRIDGE funding. The small scale of animals and the localised nature of biological vent communities means that many biological studies must rely on direct visual observation of the environment for their research data.

To ensure that biologists were fully represented within BRIDGE at Steering Committee level an additional committee position has been created. Professor Paul Tyler of Southampton Oceanography Centre has accepted this post. Professor Tyler is a macrobiologist who complements Dr Daniel Prieur, a microbiologist at the Station Biologique at Roscoff and an established member of the Steering Committee.

January 1996 saw the fourth BRIDGE Annual Science Progress Meeting. This year's meeting was held at the University of Cambridge and a report will be published in the forthcoming issue of the BRIDGE Newsletter. Over the two days, twenty-one oral presentations were made and there was an extensive poster session. With so many UK deep ocean researchers present, and with BRIDGE approaching its final round of funding, the opportunity was taken to hold an open forum discussion on the future direction of British deep ocean research. It is imperative that the knowledge gained, expertise perfected, and multidisciplinary networks developed, during a programme of this nature, are exploited for a longer term benefit, and not allowed simply to dissipate when the original funding expires. The BRIDGE community is already planning that long term future.

As a programme of the UK's Natural Environment Research Council (NERC), BRIDGE shares the NERC's concern that scientists should explain to the public what they are doing and why. BRIDGE's drive to increase the public awareness of ridge science will be given a boost in September when a full day will be devoted to BRIDGE research at the Annual Meeting of the British Association for the Advancement of Science (BAAS), to be held at the University of Birmingham. The annual BAAS meeting is one of the rare occasions when journalists attend a scientific meeting and media coverage is a real possibility.

BRIDGE Cruises

In November/December 1995 Martin Sinha (University of Cambridge) was the Chief Scientist on a BRIDGE cruise to the Valu Fa Ridge, Lau Basin, aboard the *RV Maurice Ewing* (EW95-12). The objective was to carry out a controlled source electromagnetic and seismic investigation of the ridge, which lies within one of the five BRIDGE geographical areas. By all reports the ship had no sooner sailed than the technology declared war on the science crew, but after four weeks of combat even mass suicide on the part of the equipment could not prevent the scientific objectives being achieved. Humans - 1 : Machines - 0.

As this is being written, Roger Searle(University of Durham), InterRidge Chairman, is at sea on a BRIDGE cruise aboard *RRS Charles Darwin* to further understanding of the processes by which new oceanic lithosphere is created and modified at the Mid-Atlantic Ridge, by means of passive geophysical surveying and some rock sampling (CD99). Following on from that cruise, CD100 led by Joe Cann and Donna Blackman (both University of Leeds) will be investigating crustal deformation and serpentinite intrusion in the NOBSKA spreading segment on the MAR.

In September, CD102, led by Martin Palmer (University of Bristol) and Bram Murton (Southampton Oceanography Centre) will be sediment coring on the MAR and carrying out shipboard experiments. Bram Murton will be collecting the moorings he deployed during CD95 (FLUXES 1) in August and September of 1995.

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CanRidge

SO-109 Leg 2:

Victoria, BC, (5 June) to Astoria, Oregon (26 June)

This ROV cruise to Axial Seamount on the Juan de Fuca involves collaboration between Canada, Germany and the US. The German research vessel *RV Sonne* will act as support ship for the Canadian remotely operated vehicle ROPOS. Cruise objectives include:

1) Determining the near and far field element dispersion from a high- and low- temperature point source.
2) Studying the temporal variation in physio-chemical fluid compositions and the evolution of sulfide-sulfate-silica deposition.
3) Establishing the precise relationships between volcanic, tectonic and hydrothermal activity within the caldera of Axial Seamount.
4) Examining the evolution of a newly erupted vent field.
5) The cruise also has the engineering objective of demonstrating the full range of technical capabilities of ROPOS operating from the *RV Sonne*.

CHIEF SCIENTIST: Peter Herzig (Freiberg University of Mining and Technology)
CO-CHIEF SCIENTIST: Bob Embley (NOAA)

PARTNER INSTITUTIONS:
Freiberg University
GEOMAR Kiel
Heidelberg University
Geological Survey of Canada
Institute of Ocean Sciences (Canada)
University of Victoria
NOAA -PMEL (Seattle & Newport)

Project: Endeavour Ridge 1996 - Vertical Mineral and Carbon Fluxes at Endeavour Ridge

Ship: *CSS J.P. Tully*.

Victoria (17 June) to Victoria (29 June).

This is the third cruise of a multi-disciplinary, multi-institutional survey at Endeavour Ridge and environs involving the Institute of Ocean Sciences (Sidney), the University of Hawaii (Honolulu), the Pacific Marine Environmental Laboratory (NOAA, Seattle) and other participating institutions. Our scientific goals are to quantify the impact of hydrothermal venting and associated plankton aggregations on the upward and downward fluxes of minerals and organic carbon in the deep ocean. Specific tasks for the 1996 survey are to:

1) Recover two long-term mooring strings supporting conventional and inverted sediment traps and currents meters to a depth of 1500 m. The moorings are presently located at 47°57.00'N, 129°05.61'W (main vent site) and 47°55.96'N, 129°09.84'W (to west of main vent site).
2) Use combined CTD-T and rosette bottle profiles to determine the downstream change in plume chemistry, with primary focus on manganese, iron, ammonia, methane and trace metals.
3) Use a tow-yo system consisting of a 150 kHz acoustic Doppler current profiler (ADCP), multi-net Tucker trawl and CTD-T to map the spatial distribution and composition of zooplankton biomass and other acoustic scatterers in relation to the non-buoyant plume.
4) Deploy a profiling camera/video system to characterize the distribution of large suspended particles within the vicinity of the ridge.
5) Obtain water column profiles of the composition and distribution of microzooplankton within the vicinity of the ridge.
6) Deploy an upward-looking, 1-second sampling, high data capacity 150 kHz acoustic sounder at the main vent site for 1 year to measure temporal variability of zooplankton concentrations over the lower 400 m of the water column.

CHIEF SCIENTIST: Richard Thomson (IOS)
CO-CHIEF SCIENTIST: James Cowen (UH)
PRINCIPAL INVESTIGATORS: Brenda Burd (IOS), J. William Lavelle (PMEL), Edward Baker (PMEL), Steve Calvert (UBC), Lou Hobson (UVic), Stuart Wakeham (Skideway)

PARTNER INSTITUTIONS:
Institute of Ocean Sciences (IOS)
University of Hawaii
Pacific Marine Environmental Lab. (PMEL)
University of British Columbia (UBC)
University of Victoria (UVic)
Skideway Institution of Oceanography

BioROPOS 1996

Seattle, Washington (15 August) to Seattle, Washington (27 August)

This multi-institutional cruise involves the staging of ROPOS operations form the University of Washington vessel *RV Thomas G. Thompson*. Four Canadian universities will be participating in the cruise along with several US

institutions. We will be sailing to the Main Vent Field on Endeavour Segment of the Juan de Fuca Ridge, and possibly conducting a short dive series at nearby Middle Valley. Scientific goals of the cruise include:

1) Continuation of time series biological operations and mosaic mapping on the S&M chimney structure.
2) Quantitative sampling of major biological communities.
3) Recovery and redeployment of recording thermistors.
4) Deployment of time lapse camera and recording thermistor arrays at two selected sites - one chimney and one diffuse flow site.
5) Sampling of fluids and sulfides to determine spatial patterns within the vent field
6) Study of octopus predation on vent communities.
7) Isolation of stalked bacteria and bacteria with photosynthetic genes from animal and mineral surfaces around vents.
8) Quantitative survey of microbial biomass and activity on animal and mineral surfaces.

CO-CHIEF SCIENTISTS: John Delaney (UW), Kim Juniper (UQAM), Chuck Fisher (PSU)
PARTNER INSTITUTIONS:

Université du Québec à Montréal (UQAM)	Penn State University (PSU)
University of Toronto	University of Washington (UW)
University of Victoria	Chicago Field Museum
University of British Columbia	Texas A&M University

ODP Leg 168
Begins 21 June

This ODP drilling leg will investigate diffuse off-axis venting on the eastern flank of the Juan de Fuca Ridge. This site was visited by the submersible Alvin in 1995. Dr. Earl Davis of the Pacific Geoscience centre in Sidney, British Columbia will act as Co-Chief scientist on the cruise and Marc Constantin of the University of Toronto will participate as a shipboard scientist.

ODP Leg 169
Begins 22 August

This second Sedimented Ridges drilling leg will revisit the large polymetallic sulfide deposits in Middle Valley on the Juan de Fuca Ridge and continue the study of vent field hydrology. The leg will then proceed to Escanaba Trough on the Gorda Ridge to probe a second sulfide deposit in a sedimented ridge setting. Drs. Wayne Goodfellow and Jan Peter of the Geological Survey of Canada will participate in the cruise as shipboard scientists.

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DeRidge

On February 28 1996, the 6th DeRidge Plenum was held at Oldenburg in connection with the first ODP EuroColloquium. The major topics of the first DeRidge meeting after Germany became a full member of InterRidge were 1) presentation and discussion of recent and future DeRidge projects and 2) discussion of further DeRidge activities.

1) Projects

The first phase of the EXCO (EXchange Crust - Ocean) project was carried out at the EPR (13° -15°S) with *RV Sonne* (cruise 105, PI: W. Weigel, Hamburg) in Nov/Dec 1995. The project aims at studying the variation and possible episodicity of geophysical parameters of the crust in correlation with hydrothermal circulation at distances of 0 - 8 Ma from the ridge axis. Methods applied were seismic refraction (OBS recording, energy by airgun shots), high resolution seismic refraction (OBS recording, new method of seismic energy generation by glass spheres imploding on the seafloor) high resolution seismic reflection, gravity, and heat flow measurements (the latter performed by Bremen Univ., PI: H. Villinger). The seismic velocity of 2.5 km/s at the axis was found to increase rapidly to 3.6 - 3.9 km/s in 0.5 to 2 Ma old crust and to approach 4.9 - 5.0 km/s in 5 Ma old crust, the value was observed to be rather constant further off axis (8 Ma). All heat flow values were well above 60 mW/m^2, but significantly below theoretical

values taking into account conductive heat loss only. The measured values seem to asymptotically approach the heat conduction curve determined for crustal ages > 8 Ma.

The first cruise of the Canadian-German-US HYDROCELL project took place in summer 1995 with the Canadian *RV John Tully*. H. Villinger, Univ. of Bremen, presented the preliminary results of the detailed mapping of heat flow distribution (100 m spacing) on profiles perpendicular to the spreading axis at the Juan de Fuca Ridge (JFR), which also serves as a pre-site survey for ODP drilling (Leg 168). In an area of smooth basement topography, frequency of hydrothermal cells of the order of 500 m was observed to have developed. Near the axis of JFR, > 80% of heat contributes to hydrothermal circulation, whereas in > 2 Ma old crust the measured heat flow values approach the theoretical curve for conductive lithosphere cooling. In areas of strong basement topography heat flow density correlates with sediment thickness, i.e. the top of oceanic layer 2a can be regarded as an isotherm.

P. Halbach, FUBerlin, reported on results of *RV Meteor* cruise 33/2 to the Central Indian Ridge near the Rodriguez Triple Junction (RTJ). In the vicinity of the Sonne Field, which has been investigated during previous cruises, two more (inactive) hydrothermal fields were detected, one of which must have been active until few hundred years ago, as samples of shells prove.

The methane anomaly at the Hydrothermal Plume Site discovered in 1988 was found to have decreased from 220 to 80 nl per liter. Once again the source of the methane plume could not be located.

Samples were taken from the East Side Hill, located opposite to those recovered during the 1994 *RV Sonne* cruise 92 which discovered Green Rock Hill (Lherzolithic Serpentinite diapir), however, no serpentinization was found here. Further analyses of Green Rock Hill samples proved that it was emplaced contemporaneously with generation of the surrounding basaltic crust at 750,000 years b.p. at the spreading axis.

A preview of *RV Sonne* cruises 109 - 111, which are scheduled for May - July 1996 as part of the project "Rift- and subduction induced tracer distribution patterns and their implications for element fluxes within the Juan de Fuca Plate" (HYDROTRACE; PIs: P. Herzig, Freiberg, E. Suess, Univ. of Kiel and H. Villinger, Univ. of Bremen), was given by P. Herzig. A major component of the work will involve the Canadian ROV system ROPOS for sampling of fluids, precipitates, sediments, volcanics and biology from the (boiling) hot springs at Axial Seamount and the cold seeps at Cascadia margin. The distribution of tracer elements will be determined with the use of the towed scanning systems ZAPS and SUAVE.

R. Rihm presented the major objectives of the recent ODP proposal 481 aiming at i) evaluating tectonic and magmatic processes involved in the initiation of oceanic crust along a four-site transect across the western Red Sea flank off Sudan, ii) penetrating the stockwork below the Atlantis II Deep, which hosts sediments with metal contents two orders of magnitude larger than any other known deposit on the ocean floor, and evaluating the hydrothermal system associated with it, and iii) recovering high resolution sedimentary sequences back to the Miocene in the northern and southern Red Sea to evaluate paleoclimate evolution.

2) Further activities

The first issue of the DeRidge Newsletter, which was published in December 1995, was mainly focused on summarizing the past ridge-related research of German scientists and groups. Since neither money nor personnel is available within the DeRidge initiative to maintain a 6 monthly journal-type publication like the BRIDGE or the InterRidge Newsletter, future issues of the DeRidge Newsletter will be much shorter (around 5 pages) and give (at least once per year) an overview of recent and planned projects. This will be paralleled by inclusion of the same information in the DeRidge Homepage, which is scheduled to appear and be maintained in the world wide web (WWW) this spring on the GEOMAR server "pangaea".

During an intense discussion about the perspectives of the DeRidge initiative, two major needs were emphasized: i) interdisciplinary co-operation between geology/geophysics, oceanology and biology is fundamental for scientifically successful projects, and ii) stronger thematic and/or regional focusing will be necessary to raise the funds needed for realisation of such projects. To discuss how these requirements can be met, a two or three day planning workshop will be held in early October 1996.

The call for bids to host the InterRidge office after 1997 was discussed and a consensus was reached that Germany would not be in the situation to run the InterRidge office before the next term (i.e. after 2000).

The next DeRidge plenum (after the fall 96 planning workshop) is, as every year, scheduled in connection with the next ODP Colloquium, which in 1997 will be held in Kiel.

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DeRidge Newsletter - Table of Contents

Dorsales

The last meeting of the Comité Dorsales took place in March 1996. At the pervious meeting of the Comité, it was decided that France would bid to host the InterRidge Office for the period 1997-2000. The proponent of the bid and potential future Chair is Mathilde Cannat of CNRS URA 736/ Université de Paris 6.

There are currently a number of projects recognised as part of the Dorsales programme or in which members of the Dorsales community participate jointly with other nations.

Biology

Following a workshop entitled "The Structure and Phylogeny of Proteins", 10 proposals and several letters of interest have been received aimed at investigation into the biology of organisms associated with hydrothermal circulation. Four of the proposals have been funded and another call for proposals will be issued at the Colloque de Banyuls.

Geophysics

The Mantle Project was recently funded and will soon be underway.

Two projects based on altimetry data were approved for funding: Development and evolution of axial segmentation at slow to intermediate spreading rates from altimetry data: Implications for the thermal structure of the upper mantle below the ridge; and Links between accretionary processes and those occurring at hotspots: examples of hotspots on- and off-axis at active ridges in the Atlantic and Pacific Oceans.

The Magnetism Workshop, held in June 1995, has led to technical development projects to construct a deep-towed 3-component magnetometer which could also be used with a submersible and a magnetometer to be used in unmanned flights of remote controlled aircraft.

Petrology

Following a workshop entitled "Dating Ocean Basalts" several proposals have been received. These will be considered at the next meeting of the Comité Dorsales.

Mapping

The synthesis of French bathymetric data from the region 40°N to south of the Kane Fracture Zone is now complete. The synthesis will be published at scales of 1/1,000,000 and 1/2,000,000 and the gridded data will be available in numeric form on a server or on disk in the near future.

Call for Proposals

Biology: A call for resubmission of proposals not funded in the 1995 round of awards and a new call to be issued following the Colloque de Banyuls.

Geoscience: Magnetism, composition and structure of the oceanic lithosphere at the axis, and dating of young basalts.

La Lettre Dorsales - Table of Contents

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Korea

There have been several important developments in the marine science community of the Republic of Korea (South Korea) in recent years. By the end of 1996, three new world-class research vessels will have been added to its fleet (Table 1). The first of its kind is *RV Onuri*, a 1400-ton, 64-meters long, multi-purpose research vessel, launched in early 1992 by Korea Ocean Research and Development Institute (KORDI). On March 15, 1996, *Haeyang 2000*, a 2500-ton survey vessel, was commissioned by the Office of Hydrographic Affairs (OHA). This ship, built by Korea Tacoma Marine Industry, is the largest among Korean research/survey vessels. The third to be added is a 2000-ton seismic research vessel, tentatively named *UT723*, which is currently under construction in Norway and is expected to be delivered to the Korea Institute of Geology, Mining and Materials (KIGAM) as early as December 1996. All three ships have the capability to conduct long-range open sea surveys and are equipped with the latest scientific instruments, including multibeam bathymetric echosounders. It is hoped that the acquisition of these research vessels will form the cornerstone as Korea strides to join the ranks of the international mid-ocean ridge community and other efforts in deep-sea research.

Table 1. Particulars of recent Korean research vessels

Operating Indtitute	KORDI	KIGAM	OHA
Vessel name	*RV Onuri*	*UT723*[1]	*SV Haeyang 2000*
Year Built	1992	expected late 1996	1996
Place built	Mjellem & Karlsen Yard, Norway	Ulstein Int., Norway	Tecoma Marine Industry, Korea
Overall length (m)	63.8	64.4	89.2
Breadth (m)	12	15	14
Gross Tonnage (tons)	1422	~2000	2533
Cruising speed (knots)	15	~14.5	15
Endurance (nautical miles)	10,000	~12,000	14,000
Complement (persons)	41	49	50
Multi-beam echosounder	SeaBeam 2000	Simrad EM 12S	SeaBeam 2100 (12/36 kHz modes)
Seismic instruments	96 channels, 3-km long streamer, airgun system	>200 channels airgun system	n/a
Gravity/ Magnetometer	yes	yes	yes
Navigation system	Integrated GPS	Integrated GPS	Integrated GPS

[1] provisional

Although many Korean scientists have expressed their interest, at present there is very little organized participation by Korea in international mid-ocean ridge programs. *RV Onuri*, however, has been successfully deployed in a number of deep-sea programs conducted largely by KORDI, including multi-disciplinary studies of the East Sea (Sea of Japan) and manganese nodule surveys of the Central Pacific near Clarion and Clipperton Fracture Zones where the country has a registered mining site. It has also partly been involved in surveys around Bransfield Strait, Antarctica, where Korea has a permanent research station at King George Island.

The East Sea project, namely the Basin Structure and Past Changes in the East Sea, Korea (PI: Sang-Joon Han, KORDI), is entering its second year and is expected to continue till 2001. It comprises complete multibeam bathymetric,

seismic, gravity, and magnetic surveys of the Korean sector of the East Sea which is a back-arc basin. The manganese nodule project (PI: Jeong-Keuk Kang, KORDI) is also a multi-year program funded by the Ministry of Commerce and Industry and involves studies not only of technical aspects of deep-sea mining and exploration but also of the deep-sea environment.

During its initial phase, KIGAM will direct its seismic vessel to studies of hydrocarbon prospects around the Ullueung Basin in the East Sea and to aid geological mappings around Korea. Ship time after this phase has yet to be determined.

Unlike KORDI and KIGAM, which are under supervision of the Ministry of Science and Technology, OHA is a branch of the Ministry of Construction and Transportation. Therefore, the question of how accessible *Haeyang 2000* will be to the marine scientific community remains unclear. The commission of *Haeyang 2000* comes amid a much publicized territorial dispute between Seoul and Tokyo over the Tokto islets in the East Sea. The current OHA plan includes full-coverage hydrographic and oceanographic surveys of the Korean Waters of the East Sea in the next three years.

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Mexico

Through several oceanographic expeditions since 1978, Mexican scientists have participated with scientists from other countries such as the USA and France, in the exploration of the East Pacific Rise at 21°N in the mouth of the Gulf of California and into the Guaymas Basin between 27° and 28°N in the Exclusive Economic Zone of Mexico. The projects were to be part of a general geological-geophysical, biological, physical and geochemical programme using both surface ships and submersibles from France and USA, and Mexican ships from the University of Mexico and from the Mexican Navy. These include research vessels such as: *RV Famous, RV Glommar Challenger, RV Nadir, RV Lulu, RV Atlantis II, RV El Puma,* as well as others from the Mexican Navy. Moreover, submersibles have been used to explore and to collect samples and make direct observations; these include: Cyana, Alvin, Nautilus and Turtle. Recent mapping in the last three years at the East Pacific Rise has been carried out using the SeaBeam 2000 at the mouth of the Gulf of California and in the Pacific Ocean of Mexico; such expeditions were headed by Scripps Institution of Oceanography.

OCEANOGRAPHIC EXPEDITIONS in 1996:

A project in collaboration with USA aboard the *RV Roger Revelle* operated by Scripps, proposes to conduct marine geophysical research in waters subject to the jurisdiction of Panama, Costa Rica and Mexico, during 1-31 July 1996, along the trench on part of the Cocos Plate, in order to examine the structure of the oceanic crust just before it underthrusts the continental slope.

SCIENTIFIC MEETING in 1996:

Geological Society of America Penrose Conference:
"Tectonic Evolution of the Gulf of California and its Margins"
Loreto, Baja California Sur, Mexico. April 16-21, 1996.

Dr. Joaquin Eduardo Aguayo Camargo
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RIDGE

RIDGE is working in co-ordination with the NOAA VENTS Program to plan a response to the recent event on the Gorda Ridge. On 28 February 1996, intense seismicity was detected in the northeast Pacific Ocean using the T-phase Monitoring System developed by NOAA/PMEL to access the U.S. Navy's Sound Surveillance System (SOSUS) in the northeast Pacific. The NOAA ship *RV MacArthur* was available and was sent to the site, equipped primarily to look for a water column signal associated with the seismic events. This was a cruise involving both NOAA and university-based investigators. The initial rapid response cruise has now returned to Seattle after successfully locating a large event plume ('megaplume') near 42°40'N, 126°47'W over the Gorda Ridge. See the NOAA/PMEL WWW site for details of the seismic event and the initial response cruise results:

http://www.pmel.noaa.gov/vents/eruption.html

NSF has agreed to provide funding for a second response cruise on the UNOLS ship, *RV Wecoma*, out of Newport, Oregon, to the Gorda Ridge during the first two weeks of April 1996. The focus of this cruise will be water column work and camera tows. Updates related to the event response will be posted at the NOAA/PMEL WWW site.

As the Mantle MELT Experiment winds down, efforts related to the establishment of a seafloor observatory and the investigation of larval dispersal processes will increase. The goal of the Larvae At Ridge Vents (LARVE) Project is to investigate larval dispersal and gene flow in vent environments and evaluate the potential role of these processes in generating and maintaining biogeographic patterns along mid-ocean ridges and across ocean basins. The primary location for LARVE research will be between 9°-10°N on the East Pacific Rise. The central goal of the Juan de Fuca Ridge Seafloor Observatory is to understand the causal links among magmatic, tectonic, and hydrothermal processes occurring along the ridge system, as well as the changes in these activities including variability in mass and heat fluxes, changes in the plume dynamics and chemistry, and differences in associated biological communities. Both projects have planned durations of at least 5 years. More information regarding these projects can be retrieved from the RIDGE Program WWW site:

http://ridge.unh.edu

In December, RIDGE hosted the annual Smoker during the Fall Meeting of the American Geophysical Union in San Francisco, California. More than 250 people attended the event, many from the InterRidge community.

A workshop dedicated to research along the Southern East Pacific Rise was convened by M. Mottl, E. Baker, K. Macdonald, J. Sinton, and G. Wheat in Monterey, California during mid-January. The goals of the meeting were to exchange information about past, present and planned fieldwork on the Southern East Pacific Rise, to identify the major outstanding problems regarding mid-ocean ridge processes and fluxes, and to develop ideas and long-range plans for solving these outstanding problems. A Workshop Report will be available from the RIDGE Office this summer.

The RIDGE Office will soon be distributing CD-ROMs containing multibeam bathymetry from the Northeast Pacific Ridges and the Mid-Atlantic Ridge. These CD-ROMs contain raw multibeam files, gridded terrain models and images, and navigation information. The CD-ROMs were made at the Lamont-Doherty Earth Observatory as part of the RIDGE Multibeam Synthesis Project, led by Bill Ryan. Contact the RIDGE Office for purchase information. To preview the information contained on the CD-ROMs, connect to this Lamont WWW site:

http://imager.ldeo.columbia.edu

The latest edition of the RIDGE Events newsletter was distributed in mid-February. The next issue is due out in early July. You can reach us at:

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Sweden

Swedish natural sciences are normally not directly involved in ridge research. The exceptions are participation of scientists on ODP legs. I participated, for instance, in ODP Leg 158 to TAG. The main reason for the low degree of involvement is lack of logistics for operation in the open ocean. Ships for research are leased on an irregular basis, but high priority of the funding agencies has normally been on activities in the polar regions. The one research group that works on ridge related problems is that of myself at the Department of Geology and Geochemistry of the Stockholm University. Two graduate students are active in the group - Eva Anderssson and Hakam Al-Hanbali. Eva will hopefully present her Ph.D. thesis by the end of 1996 or beginning of 1997. Before that she will join ODP Leg 168 to the Juan de Fuca Ridge as an organic geochemist. Hakam just joined our group on March 1 after having taken a Candidatus Scientiarum degree in geochemistry at Oslo University. Since we have few possibilities to work in the field emphasis has been focused on laboratory simulations of geochemical processes in ridge environments. We have received funding that has enabled us to purchase a Coretest flow-through autoclave system for high pressure/high temperature experiments. Our group is particularly interested in abiotic organic geochemistry at high P/T and geochemical evidence for a deep biosphere at ridges - or rather the flanks of ridges. Eva Andersson studies the stability of organic monomers such as amino acids under redox conditions constrained by mineral buffers such as the pyrite-pyrhotite-magnetite (PPM) assemblage. She also tries to carry out Fischer-Tropsch type (FTT) syntheses of straight hydrocarbons and fatty acids in ridge-like hydrothermal experiments. Hakam Al-Hanbali will, at the outset, mainly work on stable isotopes in marine hydrothermal environments. We would, of course, appreciate intensified interaction with other groups in natural sciences. If you feel we could contribute to each others research, please contact:

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JOIDES - Ocean Drilling Program News

***JOIDES Resolution* Cruise Schedule 1995-96**

Leg	Destination	Cruise Dates	Port of Origin	Days	Transit	On Site
163	S E Greenland VRM	7 September - 28 October '95	Reykjavik, 3-6 September '95	51	9	42
164	Gas Hydrates	1 November- 19 December '95	Halifax, 28-31 October '95	48	6	42
165	Caribbean Ocean History *	24 December '95 - 18 February '96	Miami, 19-23 December '95	56	11	45
166	Bahamas Transect*	23 February - 11 April '96	San Juan, 18-22 February '96	48	8	40
167	California Margin	21 April - 16 June '96	Panama, 11-13 April '96 Acapulco 20 April '96	56	11	45
168	E. Juan de Fuca Hydrothermal	21 June - 16 August '96	San Francisco, 16-20 June '96	56	4	52
168S	Saanich Inlet**	17-18 August '96	Victoria, 16 August '96	2	-	2
169	Sedimented Ridges II	23 August - 18 October '96	Victoria, 18-22 August '96	56	6	50
170	Costa Rica Accretionary Wedge	23 October - 18 December '96	San Diego, 18-22 October '96	56	11	45

Although five day port calls are generally scheduled, the ship sails when ready.
* These legs may be switched if further study shows that currents in the Santaren Channel are more favourable for the Bahamas project on Leg 165.

Announcements and Notices

MID-ATLANTIC RIDGE SYMPOSIUM

JUNE 19-22, 1996
Reykjavik, Iceland

Second announcement for a symposium on the Mid-Atlantic Ridge, with emphasis on the region between 15°N and 40°N. The meeting will take place in Iceland to provide the opportunity for investigators to present and discuss their recent results both in scientific sessions and in the context of field trips to active volcanic zones.

Organising Committee
Charles H.Langmuir
H. David Needham
Roger C. Searle
Heather Sloan

Scientific Committee
Henri Bougault
Aline Fiala-Médioni
Charles H. Langmuir
Catherine Mével
John C. Mutter
H. David Needham
Karen Von Damm

The symposium will provide a forum where the results of this diverse and extensive work can be compared and synthesized, and where future research objectives can be formulated. The meeting, sponsored by French and US science agencies to mark the end of the FARA project, is being convened under the auspices of InterRidge and hosted by The Nordic Volcanological Institute at the University of Iceland. It is supported as a Ewing symposium by Lamont-Doherty Earth Observatory and papers will be published in a Ewing Symposium volume. Contributed abstracts will be published as a citable volume in the *Journal of Conference Abstracts*.

The four day Symposium will include three full days of scientific presentations, debate and discussion. The symposium will begin with an overview session and culminate in a general discussion of progress and futue directions. In addition, two field trip/excursions are planned as part of the Symposium program. A half-day trip will take participants north from Reykjavik along a section of 2.8 Ma old rocks and then eastwards into zero aged rocks of the volcanic rift zone. An afternoon-evening trip will visit the Reykjanes peninsula. The full provisional Symposium program will be announced shortely to registered participants.

A three day Pre-Symposium field trip, led by Karl Gronvold of the Nordic Volcanological Institute, University of Iceland, will explore the vicinity of Kirkjubaejarklaustur in southeastern Iceland.

For information concerning the Symposium please contact:
The InterRidge Office,
Department of Geological Sciences, University of Durham,
South Road, Durham DH1 3LE, UK
Tel: 44 191 374 2532; Fax: 44 191 374 2510; E-mail: intridge@durham.ac.uk

ODP - InterRidge - IAVCEI Workshop

The Ocean Lithosphere & Scientific Drilling into the 21st Century

26-28 May 1996
Sea Crest Conference Center, North Falmouth, MA, USA

Convenors:
H.J.B. Dick (USA)
C. Mével (France)

Steering Committee
M. Cannat (France)
M.F. Coffin (United States)
J.R. Delaney (United States)
R.S. Detrick (United States)
R.A. Duncan (United States)
K.M. Gillis (Canada)
P.M. Herzig (Germany)
E. Kikawa (Japan)
J.A. Karson (United States)
J.L. Karsten (United States)
C.J. MacLeod (Great Britain)
J.H. Natland (United States)
P. Pezard (France)
R. Searle (Great Britain)
D. Stakes (United States)
K. Tamaki (Japan)

This symposium and workshop is jointly sponsored by the JOIDES Planning Committee of the Ocean Drilling Program, the InterRidge Steering Committee for an internationally co-ordinated study of ocean ridges, and the Commission on Large-Volume Basaltic Provinces of the International Association of Volcanology and Chemistry of the Earth's Interior. Its purpose is to plan an integrated program of scientific ocean drilling to evaluate and extend the current models for the formation of laterally complex and heterogeneous ocean lithosphere. This program must include drilling in crust formed at fast and slow spreading ridges, near and far from mantle hot spots, and large oceanic igneous provinces (LIPs) formed outside the framework of the global ridge system.

PROVISIONAL PROGRAM

Introduction and Welcome to Woods Hole
Composition and Structure of the Ocean Lithosphere
Present Knowledge and Major Gaps: Overviews
The Volcanic Edifice and Shallow Crust
The Lower Ocean Crust and Upper Mantle
Oceanic Large Igneous Provinces
Choosing Targets and Drilling Them
The Technology of Hard Rock Drilling in the Oceans
Holes - Not Just a Place to Store Water
Down to Brass Tacks

A dinner hosted by USSAC will be held at the Clark Laboratory, Woods Hole Oceanographic Institution.

Late applications will be accepted on a space available basis.
For Information or to Apply Contact:
InterRidge Office: intridge@durham.ac.uk

InterRidge — LIPs

SCIENTIFIC COMMITTEE ON OCEANIC RESEARCH (SCOR) GENERAL MEETING

16-17 September 1996

and

THE RIDGES SYMPOSIUM:

Linked Mass and Energy Fluxes at Mid-Ocean Ridges

18-19 September 1996

Sponsored by: **SCOR Working Group 99**

To be held at:
Southampton Oceanography Centre,
Empress Dock, Southampton,
SO14 3ZH, UK

For further information please contact: Dr. Martin Sinha sinha@esc.cam.ac.uk

The XXV General Assembly of the European Seismological Commission

9-14 September 1996
Reykjavik, Iceland

In addition to the standard Subcommission open symposia, several sessions of special interest to the mid-ocean ridge research community are planned. These include:

Special Sessions

SS-3: Seismicity and Structure of Ridges

Convenors: Pall Einarsson, Iceland, and Hideki Shimamura, Japan.

The central theme of this session will be the seismicity of active mid-ocean ridges and its relation to tectonic and magmatic processes. The subjects of crustal structure and crustal formation at constructive plate boundaries will be addressed, also faulting and fracture pattern revealed by mapping of the ocean floor. Papers on recent OBS and hydrophone array (SOSUS) studies of activity along spreading centers and transform faults are particularly welcomed.

SS-4: Hot Spots: Mantle Structure and Processes

Convenors: Ingi Th. Bjarnason, Iceland, and R. White, U.K.

Many fundamental questions remain unanswered on hot spots, such as what is their depth extent into the mantle. This session covers research in all the basic fields of geoscience on mantle hot spots, including geophysics, geochemistry and geology. The session covers hot spots in general, but some emphasis will naturally be on the Iceland plume.

SS-1: Seismology, Deformation, and Structure of Volcanoes

Convenors: Freysteinn Sigmundsson, Iceland, Bill McGuire, U.K., and R. Schick, Germany.

This session seeks to promote multidisciplinary discussion about the structure of volcanoes, and the processes that operate within them. The structure of volcanoes is being mapped out using a range of techniques, which are also shedding light on the operation of internal processes. The nature of volcanic seismicity and deformation, and the relationship between the two, provide important information on mechanisms such as internal pressure changes, magma storage and transport (including dyke emplacement), the development of flank instabilities, and eruptions. Any new observations on volcano unrest, internal processes, and the evolution of volcanoes and volcanic systems, based upon seismological, geodetic, structural, geochemical or petrological studies, are very much welcomed.

Field trips

A1 Large Fissure Eruptions of the Eastern Rift Zone.

A three day pre-conference trip to the plate boundary areas in south-central Iceland, the source areas of recent major basaltic fissure eruptions (e.g. Laki 1783). Trip leader: Gudrun Larsen, University of Iceland.

A2 Tjörnes Fracture Zone, Northern Rift Zone and the Krafla Volcanic System.

A three day post-conference trip to the plate boundary areas in north Iceland. Highlights are the transform fault at Husavik, faulting structures at a rift-transform junction, and extensive rifting and volcanic products of the Krafla rifting episode 1975-1984. Trip leader: Pall Einarsson, University of Iceland.

B1 South Iceland Seismic Zone.

A one day pre-conference trip to the transform zone of south Iceland, a zone of historic, destructive earthquakes and "bookshelf faulting". Seismic hazards in Selfoss town, strike-slip faults of the 1896 earthquakes in Skeid, a visit to a seismic station of the SIL-system at Saurbaer, Hekla Volcano exhibit, 1912 faults at Selsund. Trip leader: Pall Einarsson, University of Iceland.

B2 Reykjanes Peninsula Oblique Rift, Tectonism and Volcanism.

A one day post-conference trip to the plate boundary region where the Mid-Atlantic Ridge goes on shore. Stapafell pillow lavas, Reykjanes fissure swarm, normal faults and eruptive fissures, dykes, strike-slip faults, Svartsengi geothermal power station, Krisuvik geothermal area, Graenavatn maar, Hrutagja shield volcano. Trip leader: Pall Imsland, University of Iceland.

Deadline for the submission of abstracts for the Abstract Volume and papers for the Assembly Book, Seismology in Europe, is May 1st 1996.

For further information write to:

LOC XXV General Assembly ESC, Att: Mr. Bardi Thorkelsson
The Icelandic Meteorological Office, Bustadavegur 9, 150 Reykjavik, Iceland
Fax; +354-552-8121; e-mail: esc96@vedur.is

Call for Piggy-Back/Host Proposals

The InterRidge Office proposes to act as a broker, matching projects which may be 'piggy-backed' with funded and scheduled cruises that have available time and space.

Proposals of both piggy-back projects and ship time will be published in InterRidge News and on the InterRidge World Wide Web Home Page (http://www.dur.ac.uk/~dgl0zz1/). Proposal submission should include:

- for ship time proposed:
  - objectives and dates of the planned cruise
  - ports of call, location of study
  - equipment to be employed/deployed
  - space (deck, lab, accommodation) and time available
- for piggy-back project proposed:
  - objectives and time required
  - shipboard equipment/facilities required
  - what equipment will be brought on board
  - space required
  - preferred location(s)

Submissions and enquiries should be directed, preferably by e-mail, to:
InterRidge Office, Dept. of Geological Sciences,
University of Durham, South Road, Durham, DH1 3LE, UK
tel: 44-191-374-2532; fax: 44-191-347-2510; e-mail: intridge@durham.ac.uk

SHIP TIME OFFERED TO PIGGY BACK PROJECTS

Replies should be sent to Dr. Krasnov at hydroth@g-ocean.spb.su
and copied to the InterRidge Office at intridge@durham.ac.uk

A 3-month cruise to the MAR is tentatively scheduled for 1996. The ship will depart from St. Petersburg, Russia, and plans to call at the Oceanology International-96 Exhibition in Brighton (UK), before proceeding to the MAR. A port call to Kiel is planned on the way back. Additional port calls could be considered if necessary. The principal study areas will be the TAG field (24°N), 26°30'N and probably 14°45'N. Scheduling for this cruise is flexible although a Spring sailing is anticipated.

The *RV Professor Logatchev* is equipped with a conventional echo-sounder, NAVSTAR and transponder navigation system, CTD, near-surface (Gloria-type) and near-bottom side-scan sonar, towed TV/photo and geophysical (electric and magnetic modules) vehicles, as well as all necessary facilities for conventional geological sampling and the Preussag heavy hydraulic grab sampler. The large size of the ship (about 5 thousand tons) and the variety of winches allow a wide range of equipment to be brought on board.

Additional information about the InterRidge Piggy-Back Project Service may be found via the InterRidge Home Page:

http://www.dur.ac.uk/~dgl0zz1/

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INTERNATIONAL SYMPOSIUM: PLUMES, PLATES AND MINERALIZATION [PPM'97]

University of Pretoria, South Africa
14 to 18 April 1997

Guest speakers:

Prof Lew Ashwal: anorogenic magmatism
Dr Mark Barley, Western Australia: plumes and mineralization
Dr Ian Campbell, Canberra:Yilgarn
Dr Millard Coffin, Texas: large igneous provinces
Dr Richard Ernst, Ottawa: plate reconstruction
Prof Stephen Haggerty, Massachusetts: superplumes
Dr Nazario Pavoni, Zurich: bipolar mantle convection
Dr Neil Phillips, New Zealand: fluid migration in Wits basin
Prof Alan Smith, Cambridge UK: computer-aided plate reconstruction
Dr Bryan Storey, Cambridge UK: Phanerizoic plumes
Dr Robert White, Cambridge UK: plumes and continental breakup
Prof Maartin de Wit, Cape Town: Archaean supercontinents
Prof Maartin de Wit, Cape Town: Archaean superplumes

Excursions:

Pre- and post-symposium excursions to (planned)
Witwatersrand geology and Bushveld Complex

Workshops:

Exploration models with focus on Africa (planned)
Seismic profiles through Kaapvaal Craton
Seismic imaging of the Witwatersrand
Computer-aided plate reconstruction
Geoscience teaching in Africa

For more information please contact: Sybrand de Waal, Chairman Organizing Committee
Tel: (012) 4202454; Fax: (012) 433430; E-mail: ppm97@scientia.up.ac.za

AN ECTM-NorFA SPONSORED SUMMER SCHOOL OCEAN CRUST AND OPHIOLITES

ICELAND, 23th -31st AUGUST 1996

This summer school, organised by the Nordic Volcanological Institute, will offer a review of our present understanding on deep mantle and crustal processes during ocean ridge formation, as constrained by available knowledge on active oceanic ridges and ophiolites. Leading authorities on ophiolites and oceanic ridges will give keynote lectures on the subject while participants can present their ongoing projects for informal discussions with the teachers. Formal lectures and informal workshops will be mixed with excursions to the active rift zones and deeply eroded Tertiary crust of Iceland.

Lecturers/teachers will include Robert Detrick, Adolph Nicolas, Thierry Juteau and John Sinton in addition to staff members of the Nordic Volcanological Institute.

The summer school will be held at Kirkjubaejarklaustur, which is a small village in SE-Iceland, favourably located for short excursions to the active rift zone to the west and the deeply (1-1.5 km) eroded Tertiary crust to the east. The village is flanked on one side by thick subaquatic hyaloclastite formations and on the other by the two largest lava flows on Earth in historic times, the Eldgjá lava of 934 AD. and the Laki lava flow of 1783.

European post graduate students and post doctoral researchers, with an active interest in ocean ridge or ophiolite related studies, are invited to apply for participation in the summer school. Applications containing a curriculum vitae and the reasons for active interest in the summer school should be sent to the organisers before June 1st 1996. It is expected, but not obligatory, that participants prepare a poster describing their research project to facilitate exchange of ideas between students and teachers. The title of the poster should be included in the application. It is anticipated that travel and subsidence of participants will be fully covered by the sponsors.

Further information on the summer school is posted on the Nordic Volcanological Institute's homepage: http://www.norvol.hi.is/index.html

For information or applications contact: Karl Grönvold
Nordic Volcanological Institute, Reykjavík, Iceland
Fax: +354 562 9767 e-mail karl@norvol.hi.is

InterRidge Researcher Electronic Directory/Maillist

This form may be used to add your name to the InterRidge Researcher Electronic Directory, the maillist, the electronic maillist and/or as notification of change of address.
The InterRidge Researcher Electronic Directory contains a listing of each researcher's field of interest and expertise as well as their full coordinates. The Directory is accessible on the World Wide Web via the InterRidge Home Page (http://www.dur.ac.uk/~dgl0zz1/) making it possible to carry out effective searches quickly and easily.
If you would like to be listed in the directory please complete this form and send it to the InterRidge Office.

Please indicate whether you would like your name to appear on ☐ *International Ridge Researcher Electronic Directory,* ☐ *the maillist,* ☐ *the electronic maillist (be sure to include your e-mail address),* ☐ *The Ridge Crest Biologist Directory.* ☐ *This is a change of address notice.*

Name _____

Department/Institute _____

Address _____

_____

City _____ **State/County** _____

Post Code _____ **Country** _____

Tel.: _____ **Fax.:** _____

country code area code number country code area code number

e-mail: _____

Name of your national ridge research program: _____

Which InterRidge Program Theme(s) is of interest to you?

☐ Active Processes ☐ Meso-Scale Studies ☐ Global Studies

What are your fields of interest/expertise?

☐ Biochemistry
☐ Biogeography
☐ Biology
☐ Crustal structure
☐ Ecology
☐ Electromagnetism
☐ Engineering/Instrumentation
☐ Event detection and response
☐ Genetics
☐ Geochemistry
☐ Gravity
☐ Hydrology
☐ Hydrothermal vents/plumes
☐ Magnetism
☐ Microbiology
☐ Modelling
☐ Petrology
☐ Plate kinematics
☐ Rheology
☐ Seafloor Morphology
☐ Sedimentology
☐ Seismology
☐ Structural geology
☐ Tectonics
☐ Volcanology

cut

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